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With an Eye to the Future

SITTING AT AN EDITORIAL DESK in New York early this summer proved an uninteresting and discouraging assignment. Chemical industry was at its statistical low-point for the year and everyone was sure that business was going to be worse in July and August. All eyes were on Wall Street, awaiting the unfavorable comparisons of this year's earnings with those of last. No one dared look very far further trouble from Washington or Europe. It ahead, unless it was to forecast the imminence of was from such a depressing atmosphere that we made our escape in mid-June—intent on finding some place where things were happening in the process industries, where people were not content to sit and wait for business to improve.

That decision proved a good move for all concerned. The very day we left New York the stock market started upward and scarcely hesitated in its climb during the entire seven weeks we were away. Chemical industry reversed its seasonal trend and turned in much better records for both July and August.

In the meantime we were traveling—almost 11,000 miles in 25 states to visit nearly 100 plants and to talk with several hundred chemical engineers and executives. Purposely, we picked out the spots where interesting things were happening. We found that Baton Rouge, La., for example, had never known there was a depression—let alone a more recent recession. Houston, Texas, was a scene of encouraging activity, especially in the petroleum refineries. Carlsbad, New Mexico, quickly dispelled any doubts about the future of our potash industry which, since 1931, has grown to such giant stature. On the Coast, Boulder, Bonneville and Grand Coulee seemed like great electro-magnets to attract and hold industrial interest. A short trip from Spokane up to Trail, B. C., gave us a chance to revisit Canada's largest chemical and metallurgical enterprise. Finally, homeward-bound, we stopped for a couple of days in Montana to see first-

hand, what private industry is doing to develop those western phosphates so recently in the political headlines.

In all these areas, the chemical process industries seem to possess one common characteristic which, for want of better definition, we have called "youthful enthusiasm." Youth is characterized by ambitious, vigorous growth—a growth that utilizes available resources and continually looks for new opportunities. The enthusiasm and optimism of chemical industry spring from successful accomplishment of what others have often called the impossible. It draws continually upon research for new inspiration, for new fields of thought and action. In a word, its eyes are on the future, where there are no past peaks for discouraging comparisons and where the present is regarded as only a start toward a much greater development yet to come.

One cannot long remain discouraged in such an atmosphere. If only a small fraction of the plans, hopes and aspirations materialize, there can be no question about the future of our industry—or of our country.

Four times, in all, have we made this trip, back and forth across the continent. Each time we returned with renewed enthusiasm and respect for this great land of ours. It is so rich in resources, so vast, and its people are so productive, that no matter what happens to the rest of this upset world we here can and will carry on. There will be no stopping of our progress if we apply ourselves and our resources to the opportunities that are all around us.

This Third Pacific Coast issue will fail in its principal purpose if it cannot somehow carry to all its readers some measure of the deep satisfaction and inspiration that have come to those of us who have prepared it. Our industries and profession are part of a great program of advance in which the West is surely pointing the way.



From an

ANY WAGE-HOUR PROBLEMS?

MOST PROCESS INDUSTRIES appear to be in a peculiarly fortunate position with regard to the new federal wage-hour law. Their wage rates are generally above the minimum and the hours worked per week seldom exceed the requirements of the law. Fortunately, too, there will be ample opportunity to observe the way in which the problems of the textile industry, the first to be tackled, are handled by the administrator and his committee—which, incidentally, is headed by a former member of the chemical profession.

Probably the first of the process group to come under governmental scrutiny will be the fertilizer manufacturers of the South. Some time prior to the spring period of greatest activity among these concerns, two problems are likely to be raised: (1). Is fertilizer manufacture a seasonal industry as defined by the law and therefore eligible for exemption from the limits on maximum hours of work per week without overtime pay? (2). How can the status of the low-wage, part-time laborer be improved without raising prices to be charged to the farmer?

Other chemical process industries are not likely to be investigated by the administration for some time to come. Nevertheless it is the job of management in all industries to become thoroughly familiar with all the provisions of the wage-hour law and to make certain that there can be no basis for criticism or penalty if and when an investigation should be ordered.

MINERAL PREPAREDNESS

TWO MINERAL POLICIES of importance to process industries are being considered in Washington these days. Such tentative decisions as are made this year will not really settle either of these questions. Both will require thoughtful study by industry as well as government for some time to come. One has to do with governmental participation in mineral development and processing. The other is a question of stock piles for preparedness.

The public ownership and operation question has long been controversial with respect to public utilities. Almost identical controversy is developing around the question of phosphate resources and the production of phosphatic fertilizers in the West. As was previously pointed out in *Chem.*

& *Met.*, this question was made timely by the administration's desire to have Senator Pope of Idaho re-elected. The politics involved were not of great concern one way or another to chemical industry, nor is the political outcome a proper subject for editorial comment. But the fundamental phase of this question as to whether the government ought to go into the business of mining and processing phosphates is of great concern, and it is a broad question on which the phosphate issue is only a first case. No one should mistake the fact that if the government goes into the phosphate business, it will not only play havoc with an existing industry but will also pave the way toward nationalization of a dozen other minerals and industrial commodities.

Far more encouraging is the recent attitude of Congress with respect to the supply of those essential mineral and other materials called "strategics." These commodities are required, especially in periods of military emergency, in quantities greater than can be supplied from domestic sources. Some preparation must be made for adequate supply in a world so torn by armed conflicts.

The proposal has been made to Congress that the government buy such goods and store them in great stock piles against a national emergency. Impassioned opposition on the part of certain domestic producers, manganese, for example, would seem only to emphasize the urgency of this need. To the extent that these goods can be stored from domestic sources without excessive cost, that action should be taken. In general, these materials are strategic solely because domestic reserves are limited and the cost of domestic production in time of war would be extremely high, if not prohibitive.

In the case of these strategic minerals, it may well be the business of government to buy and maintain such reserves as are necessary for the national defense; but in the case of commodities like phosphate rock, quite a different situation exists. Members of Congress must clearly distinguish between these two classes of mineral commodities.

POWER ON A NATIONAL HOOK-UP

THAT AMAZING COMBINATION of engineer and politician, John D. Ross, Federal Power Administrator at Bonneville, made a startling proposal to

Editorial Viewpoint

those who want to process phosphates in Idaho at government expense. If they will build the plant, he will supply the power from Bonneville, 800 miles away. For those who question the practicability of transmitting current over such a distance, Mr. Ross said the problem could readily be solved by direct-current transmission at high voltage. He advanced the arguments that direct current losses are smaller, that distance is dependent only upon impressed voltage, that capacity of lines is increased, that the electric laws are simpler and that line construction costs are less.

Returning to Seattle on July 28, he told the Engineers Club of a much grander scheme. He proposed a great national hook-up that would tie together Bonneville, Skagit and Grand Coulee in Washington, the Fort Peck project in Montana, Kendrick in Wyoming, the proposed St. Lawrence River developments, even Passamaquoddy in far off Maine, then back to Norris, Muscle Shoals and the other TVA dams, Roosevelt and Parker in Arizona, Boulder, Shasta and finally returning to Bonneville. With such a colossal circuit, it would be easy to dispose of the power surpluses which accrue in one region in the markets which might exist in another! All a very pretty scheme, if it will work.

Direct-current transmission has intrigued electrical engineers for years. An experimental 15,000-volt line has been operating at Schenectady for some time. The main drawback, apparently, is with the conversion equipment. Rectification from low-voltage, alternating current, to high-voltage direct current is necessary, as is the reverse conversion. Conceivably rectifiers capable of handling such large energy values and high voltages may be built; but they are not practicable today. Nor is there any indication of what their cost will be. Until some conception of the cost of this converting equipment and some assurance of its reliability are available, it is impossible to judge the economic feasibility of d.c. transmission. Furthermore, there is no experience as to what will happen to wire communication systems, where such high voltages employing the ground as one circuit are employed. Communication engineers are fearful. Then, too, there is the problem of electrolysis.

Finally, there have been no occasions as yet where the limits of a.c. transmission have been taxed. Three hundred miles at today's high voltages

seem to be the limit. It is extremely problematical if d.c. transmission could improve materially upon the 93.8 per cent efficiency at which the Boulder Dam transmission lines of the Los Angeles Bureau of Power and Light now operate.

All of which makes us wonder if it might not be best to load that phosphate rock on the railroad and ship it (mostly downhill) to "cheap power at tidewater." That is the prime asset of Bonneville which will be quickly dissipated if all its power is used to promote public ownership and rural electrification.

CLOSER CHEMICAL SUPERVISION

UNDER THE NEW Food and Drug Law the Department of Agriculture will more closely supervise the marketing of many chemicals. Within the first few weeks of activity under this law there have been two significant types of action, which the chemical producers should note in order that they may not unwittingly run afoul of it.

The Government has proceeded with the seizure of "poisonous eyelash dye." This commodity contains paraphenylene diamine "which may make it injurious to users." Such action with reference to the drug or cosmetic use of other chemicals may be expected in the future. These actions will relate to any commodities which the Food and Drug Administration believes to involve public hazard. More recently, sulphanilamide, aminopyrine and cinchophen have been cited.

Even more sweeping in its implication is a second type of action taken by the Department in fixing regulations for the administration of certain sections of the new law. These sections relate to the drug usage of materials which are not recognized or commonly approved commodities. And the Administration has widely defined what "may be a new drug." The definition includes not only new materials, but also new combinations of old materials, new proportions, new dosages, or new recommendations regarding the use of drugs.

The Administration rightly feels great responsibility under the new law. In general, it will proceed cautiously, but it does not intend to leave any area open for careless or ill-advised manufacture or distribution in interstate commerce. Chemical producers should cooperate so that the law may be wisely enforced without unnecessary hardships.

West Points the Way of Progress

This regional summary of basic trends in the chemical process industries reveals many factors, such as abundant power, undeveloped mineral and agricultural resources and a growing market, that are certain to stimulate chemical engineering developments.

WITH 10 PER CENT of the plants and 8.6 per cent of the entire output of the chemical process industries of the United States, our eleven most western states are making an increasingly strong bid for national recognition.* Furthermore, because they are growing in importance, they emphasize basic trends that will undoubtedly have an influence on industrial developments in all parts of the United States. Greatly expanded facilities for power generation and utilization, newly developed resources of mineral and agricultural raw materials, and a mounting market for chemical prod-

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ucts and processes—all have combined recently to portray the West as a promising new field of opportunity for chemical engineering.

This would seem to make desirable—if not imperative—another regional inventory and survey of the chemical process industries of the West. In so doing we choose first to take a general view of the area as a whole and the peculiar reasons underlying the character of its industrial devel-

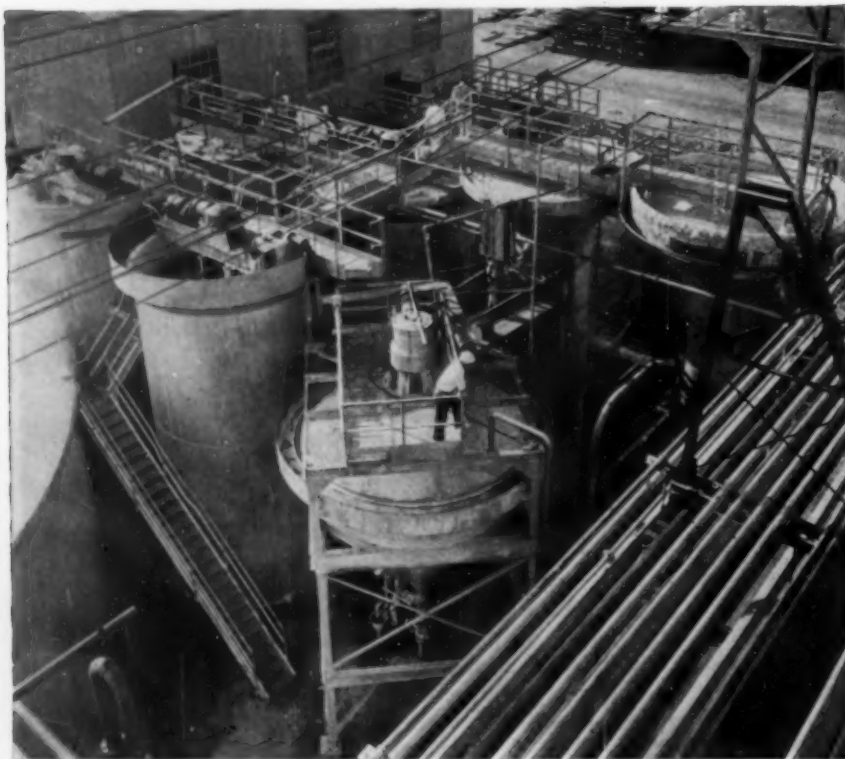
opment. Next we shall look briefly at the raw material resources. Then, with this background, we shall consider the individual industries and finally attempt to point to the trends and opportunities that must inevitably lead to new industries.

Viewed most broadly, the eleven western states divide themselves into five more or less well defined areas. Beginning at the North and traveling down the Coast, there is first the Pacific Northwest, which includes the states of Washington and Oregon. Here timber, coal and other mineral resources, lately supplemented by the prospect of abundant electric power, are the primary attractions for process industries. Next comes the Bay Area of Northern California with its well balanced industrial development based on exceptional production and distribution facilities. Southern California, centering in Los Angeles, is our third important industrial area. Here petroleum and certain mineral and agricultural resources, a growing concentration of consuming markets and further expansion of electric power production, have all had a part in promoting industrial development.

Backing up these three coastal divisions are two other great regional groups—large in territory and opportunity, but as yet somewhat less important in their development of process industries. First of these is the Mountain States of Idaho, Montana, Wyoming, Colorado and Utah, with their metals and minerals, beet sugar and other farm crops. And, finally, there is the smaller group which before the days of irrigation were sometimes called the "Desert States" of Nevada, Arizona and New Mexico. In number of plants or invested capital, their total may be unimpressive,

*See page 516 for detailed statistics of the western process industries—Editor.

Soda products digesters in new plant at Trona, Calif.





Grand Coulee, largest masonry structure in the world, will also be the largest supplier of electric energy

but here lie our principal potash and certain other mineral resources essential for national as well as regional chemical development.

Favorable combinations of raw materials and markets are the basis of most industrial developments. This writer is of the opinion that the western states now face the beginning of such a development, which is being catalyzed by the competitive advantages of delivered costs that are lower than those for nearly all of the eastern producers.

Major raw materials which form the bases for the development of western process industries include wood, minerals, fuels, agricultural products and power.

Timber Resources—To any engineer who has studied the production of lumber from timber, the apparent need is for research—not only on utilization and conservation of raw materials, but on the development of more satisfactory finished building materials. Many of these will be products of chemical and engineering research. Eventually we may look forward to more complete use of our timber resources, to provide a certain amount of lumber but with the additional production of plastics and plywood products that will make more satisfactory building material

through the utilization of what are now wastes. Reforestation programs are slowly getting under way so that our forests may some day become permanent sources of wood.

Timber resources for Oregon and Washington which are available for cutting are given in a recent report of the U. S. Army Engineer Corps office at Portland (The Pulp and Paper Industry of the Pacific Northwest) as follows:

State	Douglas Fir (Millions of Feet)	Pulp Wood (Thousands of Cords)	Area (Acres)
Oregon	232,000	114,481	15,576,452
Washington . .	99,000	263,913	13,425,458
Total	331,000	378,394	29,001,910

Douglas fir grows only in this area of the United States. Of the various species used for pulpwood, the percentages are as follows: western hemlock, 62 per cent, balsam fir, 28 per cent, and the balance of 10 per cent made of engelmann spruce, mt. hemlock, sitka spruce, and cottonwood.

It has been estimated by the Pacific Northwest Forest Experiment Station that it will be possible to produce 9,907,000 cords of pulpwood yearly, under proper forest conservation conditions. This is sufficient to yield approximately 6,000,000 tons of wood pulp—which is more than the entire U. S. requirements today.

Mineral Resources—Major developments in the use of mineral resources of the West have largely centered, as far as the process industries are concerned, in the production of petroleum, borax, potash, clays, diatomite, salines, mercury, magnesite, and cement. In an accompanying table are listed the principal resources that are available and are undergoing development. In this connection it should be remembered that raw material surveys made years ago may be profitably studied again from the new viewpoints of low cost power and improved highway transportation. Important among these mineral surveys for the western states are the following: "Non-Metallic Mineral Resources of Washington," published as Bulletin No. 33 of the Washington State Department of Conservation and Development. Metallic minerals of importance to industry are covered in Bulletin No. 30, "The Mineral Resources of Washington" and in Research Publication No. 3 of the Washington State Planning Council. These include data on abrasive clays, magnesite, chromite, copper, gold, lead, silver, zinc, limestone, coal, manganese and molybdenum. In California an annual summary, "California Mineral Production and Directory of Mineral Producers" lists the various deposits

Location and Status of Mineral Resources in the Eleven Western States*

Mineral	New Mexico	California	Washington	Colorado	Wyoming	Montana	Nevada	Arizona	Oregon	Idaho	Utah
Antimony.....	X	XX	X	X		X	XXX	X	X	XXXX	XXX
Arsenic.....	X	XX	X			XXXXX	X	X		X	X
Asbestos.....		XX	X	X	XXXX	X		X	X	X	
Beryllium.....		X		XX	X		X			X	X
Chromite.....		XXX	XX		XXX	XX			XXXXX		
Clays.....	XXX	XXXX	XXXXX	XXX	XXX	XXX	XX	XXXX	XXX	XXXXX	XXX
Cobalt.....		X	X	X	X		X	X	X	X	
Copper.....	XXXXX	XXXXX	XXXXX	XXXX	XX	XXXXX	XXXXX	XXXXX	XX	XXX	XXXXX
Gold.....	XXXX	XXXXX	XXXX		XXX	XXXXX	XXXXX	XXXX	XXXXX	XXXXX	XXX
Feldspar.....		XXX	XX		XX		XX	XXX		X	XX
Graphite.....	X	XX	XX	XX	XXX	X	X		X	XX	
Iron.....	XXXX	XXX	XXX	XXXXX	XXXX	X		XX	XX	X	XXXX
Lead.....	XXX	XXX	XXX	XXXXX	X	XXXXX	XXXX	XXXX	X	XXXXX	XXXXX
Limestone.....	XXX	XXX	XXX	XXXX	XXX	XXX	XXXX	XX	XXXX	XX	XXXX
Magnesite.....		XXXXX	XXXXX				XX				
Magnesium Sulphate.....		XXX	XX		XX						
Manganese.....	X	XXX	XX	X	X	XXXX	XX	XX	XX	XX	XX
Mercury.....		XXXXX	X				XXXX		XXXXX	XXX	X
Mica.....	X	XXX	X	XXX	XXX	XXX	XX	X	X	XXXX	
Molybdenum.....	XX	XX	XX	XXXXX	X	X	XXX	X	X	X	XX
Platinum.....		XXX	X	X	X	X	XX	X	XX		X
Potash.....	XXXXX	XXXXX		X			XX	X			XX
Pumice.....	X	XXX	X		XX				X	X	X
Silica.....		XXX	XX			X	XX			X	
Diatomite.....		XXXXX	XX			X		XXX	XXXXX	XX	XX
Silver.....	XXX	XXXXX	XXX	XXX	XXXX	XXX	XXXXX	XXX	XXX	XXXXX	XXXX
Sodium Carbonates.....		XXXXX	XX		XX				X		
Sodium Sulphate.....		XXXXX	XXX		XXXX		XXX	XX			
Sulphur.....	X	XX	X	X	XXXX	XXX				XX	X
Talc.....		X	X						X	XX	
Tungsten.....	XX	XXXX	XXX	X	X	XXX	XXXXX	XX		XX	XXX
Vanadium.....	X	X	XX			X	XX	XXX			X
Zinc.....	XX	XXX	XXX	X	XXX	XXXXX	XXXX	XX	XX	XXXXX	XXXXX
Salt.....	X	XXXX			XX		XX	X	X	XX	XXXX
Borax.....		XXXXX					XX				
Brucite.....							XX	X			X
Barite.....	X	XXX	XX		XX	XXX	X	X	X	XX	X
Celestite.....		XX	XX					XX			X
Cement Rock.....	XX	XXX	XXX	XXXX	XXX	XXXX	XX	XXX	XXXX	XXX	XXX
Gypsum.....	X	XXX		X	XXX	XXX	XXX	X	XX	XX	XXXX
Fluorspar.....	X	XXX	X	XXXX	X		XX	XX			X
Bismuth.....	X	X	X	X	X	X	X	X			X
Cadmium.....		X	X	XXXX		XXXXX				XXXXX	XXXXX
Nickel.....	X	X	X	X	X		X		X	X	
Tin.....	X	XX	X	X	X					X	
Titanium.....		XX		X	XX				XXX		
Pyrites.....	X	XXX	X		XX	XX	XXXX	XXXXX	XXX	XX	XX
Soapstone.....		XXX	X								
Potash.....	XX, XX	XXXXX									XX
Bromine.....		XXXXX					X	X			
Phosphate Rock.....					XX	XXXX				XXXX	XX

KEY: X, present but extent unknown; XX, some past production but not now operating or with undeveloped possibilities; XXX, producing or undergoing development; XXXX, fairly well developed industry; XXXXX, well developed.

* This chart has been prepared from information available in a large number of private and governmental reports, private communications, etc., with the aid of R. M. Miller of Industrial West, Inc.

and gives current statistics on production.

Fuels—Many fuels are available for use in the Pacific area. Large reserves of coal are found in Washington and Oregon with smaller amounts in California. It has been estimated by the U. S. Geological Survey that the coal available in Washington alone will total approximately 63,000,000,000 tons. Sheldon L. Glover of the Washington State Department of Conservation and Development, remarks that coal is the most valuable mineral resource of his state (see Bulletin No. 33). The U. S. Geological Survey estimated Washington coal resources prior to working as follows: anthracite and semianthracite, 23,000,000 tons; bituminous coal, 11,412,000,000 tons; and sub-bituminous coal, 52,442,000,000 tons.

Production has been estimated by Daniels in the University of Washington Eng. Exp. Stat. Rept. 1934 as 118,000,000 tons up to 1934. The

same authority also estimates Oregon coal resources as 10,000,000 tons and California as 43,000,000 tons. Washington has the only commercial supply of coking coal in the Pacific Coast area, the other nearest available supply being in Utah.

Oregon coal is found near the coast and is sub-bituminous. It is easily handled by pulverized fuel equipment as well as by certain types of stokers which are available for handling coal with a low fusing ash.

California coal reserves are rather unimportant. Mines in the Pittsburg area which were formerly operated are now inactive. The major fuels in the California region are oil and gas of which there are large supplies. Oil is available also for the Pacific Northwest at reasonable rates because of cheap transportation in tank steamers.

Chemurgic Materials—Agricultural products as resources for western process industries are, as in other sections, only partially developed. The area has large amounts of practically

all agricultural products. Grains, with the exception of corn, grow well in most western states. The beet sugar industry of Colorado and Utah is the outstanding example of chemurgic development. Cull fruits in California form a large available source for chemical byproducts. The growing of cotton in California has become a great industry during the last few years. With the completion of the Grand Coulee Dam, an enormous fertile area will be opened for irrigation thus bringing agricultural surpluses near power sources. Also available at low transportation costs from Hawaii are molasses, taro, sugar and other commodities.

Three remaining necessities for industrial development are power, labor and transportation. The power situation is undergoing a very rapid change with the building of the three major dams at Boulder, Bonneville and Grand Coulee. It seems likely that with the spreading transmission network apparently contemplated by the



Above—Magnesium products plant of California Chemical Co. at Newark, Calif.
Below—Pennsylvania Salt Mfg. Co. of Wash. (Mt. Ranier in the background)

Federal Administration, power for nearly all uses may eventually come from hydroelectric sources rather than through the use of fuels. In this issue of *Chem. & Met.*, the power situation is well summarized by my colleague, George Tenney, editor of *Electrical West*.

While general labor conditions on the Pacific Coast have been troublesome during the past few years, most of the difficulties are to be found in the shipping industry. Process and chemical industries requiring a larger proportion of skilled labor have been relatively free from such difficulties. Living conditions are good and standards high.

As in many sections of the United States, the cost of transportation is the chief retarder of industrial development. Good highways are being built as rapidly as possible with funds available from gasoline and automobile taxes. State laws are generally favorable to trucking, although trucks cannot always replace the function of

the railroad. Undoubtedly some changes must be made in railroad transportation systems whereby freight costs can be lowered. Possibly a system of off-peak freight can be worked out whereby low cost transportation can be made available at times when necessary freight loads are low, thus making operating demands more uniform.

Tax rates in practically all western states are not burdensome and quite generally favor the establishment of new industries.

Pulp and Paper—Process industries dependent on wood for raw material are localized mainly in the Pacific Northwest. The most complete and detailed study of the pulp and paper industry made in recent years is to be found in a publication prepared for the U. S. Army Engineer Office at Portland, Ore. (The Pulp and Paper Industry of the Pacific Northwest, by Miller, Hoffman, Wakeman, Griswold and Byam) from which most of the following in-

formation and data have been taken.

Capacity of pulp mills in this area in 1936 was approximately 1,400,000 tons of pulp per year of 310 days. The capacity of the paper mills on the Pacific Coast in 1936 was 1,139,800 tons per annum, divided as follows: Columbia River area, 49 per cent; Puget Sound and Grays Harbor, 23 per cent; California, 25 per cent; and Eastern Washington, 3 per cent.

Wood pulp is no longer produced in California and the production in Washington is approximately three times that of Oregon. Capacity for wood pulp is given as follows by the report of the Army Engineers:

	Daily Wood Pulp Capacity (Tons)	Capacity Per 310 Day Year (Tons)	Per Cent of Total
Columbia River Area	2,240	694,400	49.3
Puget Sound-Grays Harbor	2,099	650,690	46.2
Eastern Wash- ington	133 70	41,230 21,700	2.9 1.5
Total	4,542	1,408,020	

Embodied in these mills are exam-

Capacities of Pacific Pulp and Paper Mills, End of Year 1935*

Organization	Location	Date Est.	Daily Capacity in Tons					Sulphite Paper	Kraft Products	Board
			Mechanical Pulp	Unbleached Sulphite Pulp	Bleached Sulphite Pulp	Kraft Pulp	Newsprint Paper			
Crown Willamette Paper Co....	Camas, Wash.....	1885	90	200	100	135	....	390	110	25
	Oregon City, Ore....	1890	60	....	....	....	....	....	....	....
	West Linn, Ore....	1888	375	90	....	....	350	23	....	....
	Lebanon, Ore....	1891	....	35	....	....	....	35	....	....
Columbia River Paper Mills....	Vancouver, Wash....	1922	30	110	....	....	....	130	....	....
St. Helena Pulp & Paper Co....	St. Helena, Ore....	1926	....	....	115	....	....	120	....	....
Weyerhaeuser Timber Co....	Longview, Wash....	1930	....	....	200	....	....	....	....	....
	Everett, Wash....	....	....	150	....	....	....	....	....	....
Pacific Straw Paper & Board Co..	Longview, Wash....	1925	30	....	....	....	....	....	....	52
Longview Fibre Co....	Longview, Wash....	1927	75	....	....	130	....	....	75	150
Hawley Pulp & Paper Co....	Oregon City, Ore....	1908	170	85	....	....	135	90	....	....
Spaulding Pulp & Paper Co....	Newberg, Ore....	1927	....	90	....	....	....	....	....	....
Oregon Pulp & Paper Co....	Salem, Ore....	1920	....	20	100	....	....	120	....	....
Coos Bay Pulp Corp....	Empire, Ore....	1928	....	70	....	....	....	....	....	....
Grays Harbor Pulp & Paper Corp	Hoquiam, Wash....	....	....	....	220	....	....	....	....	....
Grays Harbor Corporation....	Hoquiam, Wash....	1928	....	....	....	....	....	50	....	....
Washington Pulp & Paper Corp.	Port Angeles, Wash..	1926	260	75	....	....	315	....	....	....
Olympic Forest Products Co....	Port Angeles, Wash..	1929	....	....	200	....	....	....	....	....
Fibreboard Products, Inc....	Port Angeles, Wash..	1917	30	54	....	....	....	....	....	75
National Paper Products Co....	Port Townsend, Wash....	....	....	....	....	250	....	....	235	....
Rainier Pulp & Paper Co....	Shelton, Wash....	1926	....	....	185	....	....	....	....	....
Soundview Pulp Co....	Everett, Wash....	1932	....	....	200	....	....	....	....	....
Everett Pulp & Paper Co....	Everett, Wash....	....	....	....	....	50†	....	....	65†	....
Everett Pulp & Paper Co....	W. Tacoma, Wash....	....	....	....	....	25†	....	....	50†	....
St. Regis Kraft Co....	Tacoma, Wash....	1928	....	....	....	180	....	....	....	....
Shaffer Pulp Co....	Tacoma, Wash....	....	....	65	....	....	....	....	....	....
Fibreboard Products, Inc....	Sumner, Wash....	....	....	....	....	....	....	....	....	75
Tumwater Paper Mills Co....	Tumwater, Wash....	....	20	....	....	....	....	50	....	....
Puget Sound Pulp & Timber Co..	Anacortes, Wash....	....	....	80	....	....	....	....	....	....
Puget Sound Pulp & Timber Co..	Bellingham, Wash....	....	....	100	....	....	....	....	....	....
Pacific Coast Paper Mills....	Bellingham, Wash....	1925	....	....	....	....	....	15	....	....
Inland Empire Paper Co....	Millwood, Wash....	....	100	33	....	....	65	50	....	....
Grand Totals, Washington and Oregon.....			1,240	1,257	1,205	885	915	953	655	377

† Soda Mills.

* Compiled from data in "The Pulp and Paper Industry of the Pacific Northwest," by R. M. Miller, et al. U. S. Army Engineers Report—1937. See also, *Pacific Pulp & Paper Industry*, July, 1936.

ples of the best chemical engineering practice in chemical recovery and bleaching. This has made possible the fine quality and low costs of many articles. As an example of efficiency obtained through research, consumption of lime and sodium sulphate in one kraft mill has been lowered to approximately 50 lb. and 150 lb. respectively per ton of pulp. All chemicals used in pulp production are manufactured on the Pacific Coast.

Mineral Industries—Chief among the minerals of which the Pacific Coast has a monopoly are diatomite and borax. The largest producers of diatomite are the Johns-Manville Corp. at Lompoc, Calif. and the Dicalite Co. operating plants near Torrance, Calif. and Terrebonne, Oregon. These operations have been described recently in *Chem. & Met.* (See Vol. 35 pp. 460-2 and Vol. 45, pp. 28-31). Other producers in this field include the Kittitas Diatomite Co., Ellensburg, Wash., Deer Park Natural Pigments, Inc., Spokane, Wash., Raylite Aggregates, Inc., Los Angeles, (deposits at Palos Verdes, Calif.), Pacatome, Ltd., Bradley, Calif., Lompoc Mining Products, Inc., Palo Alto, Calif. and the Paraffine Companies, Inc., Emeryville, Calif. Both of the last two companies have their diatomite deposits in Lompoc.

Clay products include the pottery

and brick operations of Gladding, McBean and Co. in Renton, Taylor and Mica, Washington, and in California. China clay is also being produced in Washington and used locally in the manufacture of paper. Special clays treated to develop decolorizing properties for use in oil and various chemical industries are being made on a large scale by the Filtrol Co. in Los Angeles, Calif.

Borax is a second western monopoly. There are many deposits of colemanite and ulexite throughout the western states and the world. These deposits, formerly the chief raw materials for the production of borax salts, have now been relegated to the future. Their use is no longer commercially feasible because of the low cost production of borax from rasorite and the brines of Searles Lake. The two major producers are the Pacific Coast Borax Co. at Boron and Wilmington, Calif. and the American Potash & Chemical Corp. at Trona, Calif.

Borax is also produced by the West End Chemical Co. at West End, Calif. from Searles Lake brine. This plant produces soda ash using a process depending on carbonation of the brine with carbon dioxide made by calcining dolomite or lime.

Pacific Alkali Co. operates a plant at Bartlett, Calif. on the shore of

Owens Lake, producing soda ash and borax in small tonnages. Owens Lake has been gradually drying up since the completion of the Los Angeles aqueduct which diverted the waters of the Owens River from flowing into the lake. This year, however, due to heavy snows and rain in the mountains, water has been allowed to run into the lake and this has seriously curtailed alkali operations. The plant of the Natural Soda Products Co. at Keeler, Calif., (which is controlled by the Michigan Alkali Co.) on the eastern side of the lake, has been shut down.

Portland Cement—Cement production has received an impetus by reason of the construction of so many large dams in the West. Pacific Coast production is shown in the accompanying table.

Oyster shells are used as raw material for the manufacture of cement in the plant of the Pacific Portland Cement Co. on San Francisco Bay near Redwood, Calif. Its raw material is dredged from the huge oyster shell deposits in the bay. These shells are barged to the plant, unloaded, washed and then started through the process. Organic material is burned out before the material enters the kiln. Sufficient silica is present so that the shells make up the only raw material used for the cement itself.

Portland Cement Production on the Pacific Coast

	Location	Process	Kilns	Annual Capacity (Bbl.)
Washington				
Lehigh Portland Cement Co.....	Spokane	Dry	2	700,000
Olympic Portland Cement Co.....	Bellingham	Wet	3	1,060,000
Northwestern Portland Cement Co....	Grotto	Wet	1	700,000
Superior Portland Cement Co.....	Seattle	Wet	2	1,260,000
Spokane Portland Cement Co.....	Irvin	Dry	2	630,000
Superior Portland Cement Co.....	Concrete	Wet	6	1,750,000
Oregon				
Oregon Portland Cement Co.....	Lime	Wet	1	400,000
Oregon Portland Cement Co.....	Oswego	Wet	1	400,000
Beaver Portland Cement Co.....	Gold Hill	Wet	1	650,000
California				
Calaveras Cement Co.....	San Andreas	Wet	2	1,100,000
Henry Cowell Lime & Cement Co....	Cowell	Dry	8	1,440,000
Monolith Portland Cement Co.....	Monolith	Wet	4	2,000,000
Yosemite Portland Cement Co.....	Merced	Wet	2	900,000
Riverside Cement Co.....	Riverside	Dry	19	4,500,000
California Portland Cement Co.....	Colton	Dry	9	4,200,000
Southwestern Portland Cement Co....	Victorville	Wet	4	1,900,000
Pacific Portland Cement Co.....	Redwood City	Wet	4	3,000,000
Santa Cruz Portland Cement Co.....	Davenport	Dry	18	3,000,000

Magnesite is produced both in Washington and California. In the latter state, two mines are being operated, both by the California Chemical Co. The Northwest Magnesite Co., with large deposits in Washington, operates its plant at Chewelah, Wash. Its production of dead burned magnesite is said to be the largest in the United States. In California, the work of the California Chemical Co. has been toward the production of refractory materials by suitably burning magnesium hydroxide produced from sea-water bitters.

Halogens—Oilwell brines in Southern California were found to contain iodine, a number of years ago. At that time the price of Chilean iodine set by the cartel was between \$3 and \$4 per lb. This stimulated the formation of several companies for the purpose of developing processes and establishing plants for the production of iodine.

During the early stages of the development of this new American activity, the iodine syndicate dropped the price continually, thereby greatly increasing the difficulties of the American producers. With the experience gained at Kure Beach, N. C., in the large sea-water bromine plant of the Ethyl-Dow Chemical Co., the Io-Dow Chemical Co. evolved a new process which is now in successful operation at two plants in Southern California. The process represents a clever adaptation of the bromine recovery process, is almost entirely automatic in operation and depends upon very careful electrometric control of pH. The plant at Long Beach operates on brines containing 50 to 60 p.p.m. of iodine while the Venice plant utilizes brine with about three times this concentration. The silver iodide process is being used by the Deepwater Chemical Co. under license, but the General Salt Co. has ceased operations.

Bromine is produced in California in two plants. Both are owned by the California Chemical Co., the western subsidiary of Westvaco Chlorine Products, Inc. and both utilize bitters from the production of salt made from sea water by solar evaporation. The smaller plant is located south of San Diego, while the second is near Newark, Calif.

Chlorine is manufactured by three producers: Great Western Electrochemical Co. of Pittsburg, Calif., Hooker Electrochemical Co. and Pennsylvania Salt Manufacturing Co. of Washington. The two latter plants are in Tacoma, Wash.

To utilize byproduct hydrogen, both of the Northwest producers operate oil hydrogenation plants which aid greatly in maintaining a proper economic balance in the marketing of sardine or pilchard oil. The Pacific

Coast fishing industry is a large producer of sardine oil which is used to supply vitamin D for poultry rations and, in this role, has furnished serious competition to cod liver oil. Hydrogenation of sardine oil produces a fine fat, free from fishy odor or taste.

Ammonia is produced as a by-product in gas manufacturing in two plants in Washington and by synthesis in two California plants. Great Western Electrochemical Co. manufactures liquid ammonia by the Haber process at Pittsburg, while the Shell Chemical Co. at Shell Point, uses the Mont Cenis process. Raw material for the latter is natural gas which yields benzol and briquetted carbon as byproducts. The capacity of the Shell plant is 80 tons per day of anhydrous ammonia. The use of this anhydrous ammonia as a fertilizer by direct addition to irrigation waters, has been brought to a successful conclusion by Dr. Ludwig Rosenstein of the Shell Chemical Co. (See p. 493).

Nowhere else on the Coast has research in developing and synthesizing important organic chemicals from petroleum reached the state to which it has progressed in the Shell Development Co. The new research plant located in Emeryville, Calif. is devoted to this work and to problems involved in production and refining of petroleum. A staff of about 450 chemists, engineers and physicists make up the personnel under the direction.

(Please turn to page 498)

Lime from oyster shells and magnesium compounds from sea-water bitters



Electrochemical Power

An editorial staff summary interpreting the Federal Power Commission's comprehensive report on the "Power Requirements in Electrochemical, Electrometallurgical and Allied Industries," which has just been published.

ELECTROCHEMICAL and electrothermal processes, separately or integrated with other operations, play a large part in the manufacture of products finding common usage in the daily life of almost everyone. Some of these products can be obtained by no practical means other than by the use of electric power; others are perfected or improved or given special characteristics by electric processing. Some are classed as strategic materials, essential for the national defense. Some are in common use; others assist or make possible the manufacture of important commodities of commerce.

All of these processes require electric power in such large amounts as to warrant special consideration in respect to the supply of electric power to meet the growing needs of the United States. In some regions, as on the Pacific Coast, the availability of raw materials and the present or potential availability of abundant low-cost water-power have made the electro-processing industries particularly significant to the utilization and conservation of the nation's natural resources.

In accordance with the provisions of the Federal Power Act, the Federal Power Commission has therefore made an investigation to determine the past and present use of electric power in the electro-processing industries, and the probable effect of the development of new processes, new products, and economic trends on the future power requirements of these industries. The investigation covered the principal industries using electric power primarily for electrolysis and for heat.

Information on the supply and consumption of electric power was compiled largely from statements fur-

Editor's Note:—Qualified experts of the Federal Power Commission, after several years' investigation of the past and present use of electric power in electro-processing industries, have just published their findings in a 120-page bulletin that should be carefully read and studied by all chemical engineers. Copies may be obtained for \$1 from the Federal Power Commission, Washington, D. C.

nished by the industries and by electric utilities, supplemented where necessary by estimates based on various published and unpublished data. Some of the data on the capacity of power equipment installed were supplied by manufacturers of the equipment. The statistical data, in general, relate to the period 1926 to 1936, inclusive.

Fig. 1 shows in diagrammatic form the manner in which electric energy is used in electrochemical and electrometallurgical processes and the typical disposition of the resulting products. Two functions of energy are shown—electricity for power and electricity for heat.

The interrelationship of many of the products and processes is strikingly apparent. For example, magnesium and aluminum are each produced by the electrolysis of the fused salts of the metals with the expenditure of about 10 kw.-hr. of electric energy per lb. Both metals in alloy forms are used for structural and other purposes and each is used as an alloy with the other. Electrolytic production of metallic sodium involves the production of chlorine which competes with other electrolytic chlorine produced with caustic soda or caustic potash. There are im-

portant interrelationships in the electrothermal production of ferro-alloys which are used in both electric and fuel-fired furnaces for the manufacture of alloy steels.

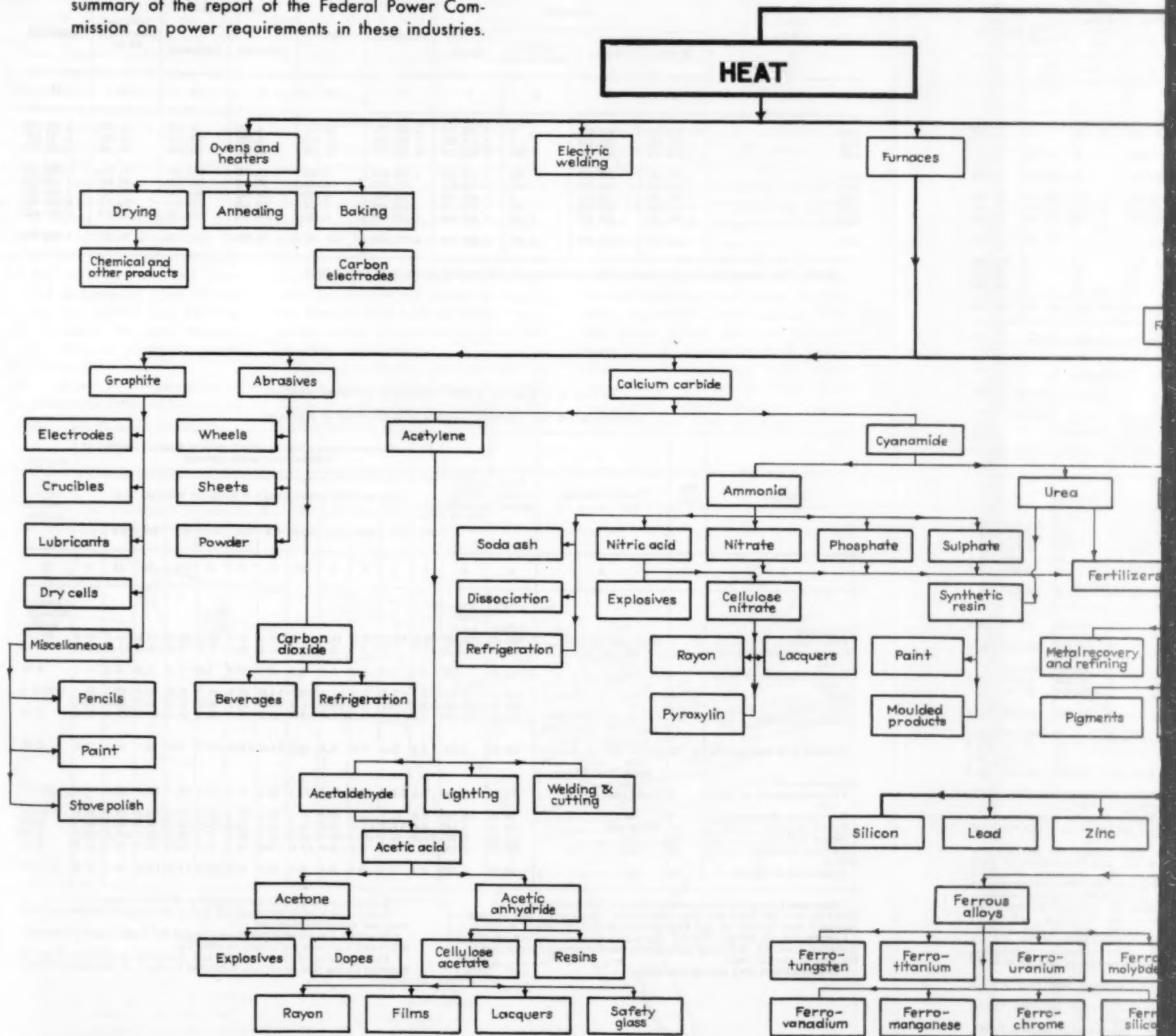
Electrolytic and electrothermal plants for the most part are situated where electric energy is available in quantity at low cost. Representatives of these are the large establishments at Niagara Falls and Massena, N. Y.; Keokuk, Ia.; Sault St. Marie, Mich.; Alcoa, Tenn.; Badin, N. C., and Tacoma, Wash. The accompanying map, Fig. 2, shows the location of the major electrolytic industries in the United States. The electrothermal industrial works cannot be adequately presented on a single map, but are presented in the original report in a series of maps and tables that include much interesting information on such products as artificial abrasives, calcium carbide, carbon and graphite, magnesium and phosphoric acid. Widespread but individually small operations in electroplating, the electrolytic production of hydrogen and nitrogen, and the electrolytic production of chlorates are not shown, because their power requirements have as yet been of relatively little significance.

The unit requirements for electric energy in various operations are shown in Table 4. Totals given for some of the processes include energy used for lighting and for motors and pumping, conveying, grinding, crushing and other services directly associated with the operation of electrolytic cells or electric furnaces. Data based on reports by the industries and information supplied by the designers of the equipment are shown in bold type. Other figures have been compiled from various published and unpublished sources.

UTILIZATION OF ELECTRIC ENERGY

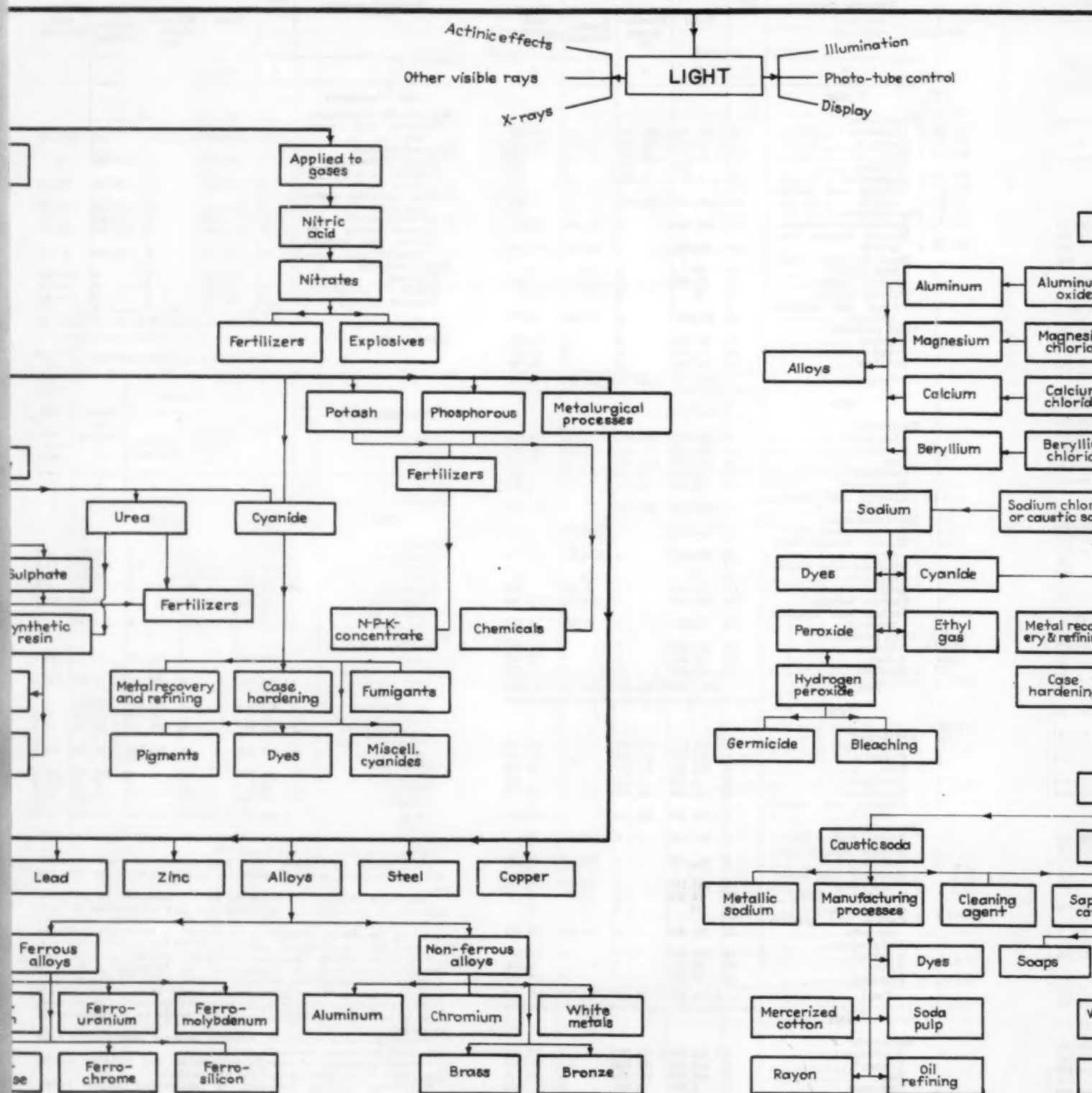
ELECTROCHEMICAL AND ELECTROMETALLURGICAL PROCESSES

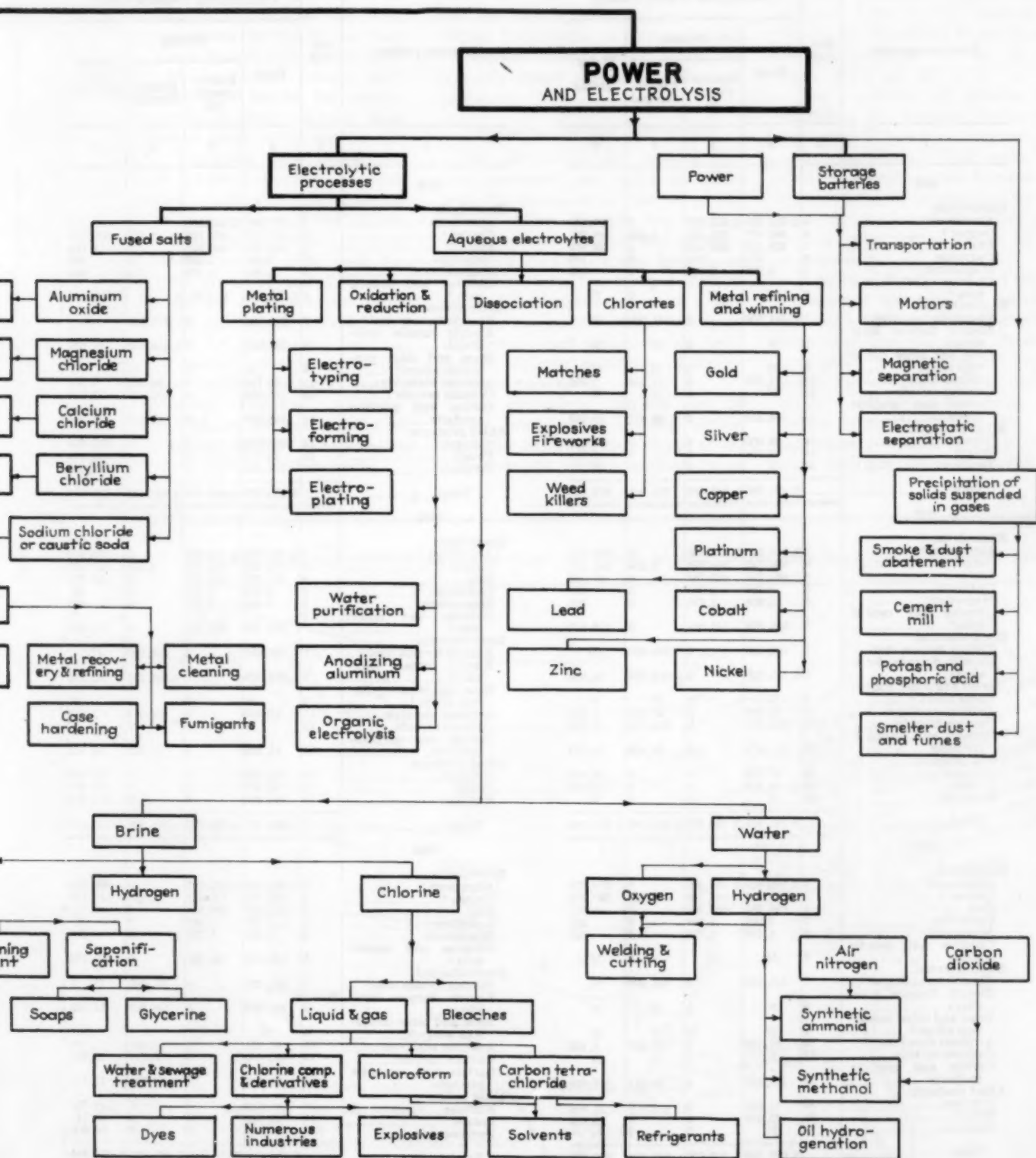
This diagram, showing the manner in which electric energy is used in electrochemical and electrometallurgical processes and the typical disposition of the resulting products, is discussed in the accompanying summary of the report of the Federal Power Commission on power requirements in these industries.



ION OF ELECTRIC ENERGY AND DISPOSITION OF PRODUCT

OF THE ELECTROCHEMICAL AND ELECTROMETALLURGICAL INDUSTRIES





Based on Data Furnished by the
Bureau of Foreign and Domestic Commerce

TABLE 1.—Consumption of electric energy in electrochemical, electrometallurgical, and allied industries, United States, 1926-36

[In thousands of kilowatt-hours]

Principal product	Section	Consumption of electric energy			
		Total	Process		Motor and lighting
			Electrochemical	Electrothermal	
1	2	3	4	5	6
1926					
Electrolytic:					
Aluminum ¹	2	2,051,000	1,823,470	0	227,530
Copper ²	3	881,467	330,103	2,480	548,884
Zinc.....	4	429,105	389,163	0	39,942
Cadmium.....	5	915	815	0	100
Magnesium.....	5	3,226	2,908	0	323
Chlorine and caustic soda ³	6	N	N	0	N
Electrothermal:					
Electric furnace steel ⁴	7	541,000	0	541,000	(⁵)
Electric furnace ferroalloys.....	8	N	0	N	N
Brass and other nonferrous alloys ⁶	9	N	0	N	N
Artificial abrasives.....	11	74,004	0	71,136	2,956
Calcium carbide.....	12	N	0	N	N
Carbon and graphite products.....	13	104,519	0	88,477	16,042
Allied products:					
Nitrogen.....	14	28,000	0	0	28,000
Potash.....	14	7,754	0	0	7,754
Fertilizer.....	14	N	0	0	N
Total.....		4,121,080	2,546,464	703,095	871,531
1927					
Electrolytic:					
Aluminum ¹	2	2,117,000	1,878,790	0	238,270
Copper ²	3	868,795	380,216	2,364	486,215
Zinc.....	4	440,915	403,783	0	37,132
Cadmium.....	5	1,210	1,060	0	150
Magnesium.....	5	3,664	3,296	0	368
Chlorine and caustic soda ³	6	856,894	740,021	0	116,873
Electrothermal:					
Electric furnace steel ⁴	7	540,000	0	540,000	(⁵)
Electric furnace ferroalloys.....	8	1,111,000	0	1,038,095	52,905
Brass and other nonferrous alloys ⁶	9	N	0	N	N
Artificial abrasives.....	11	52,556	0	50,606	1,950
Calcium carbide.....	12	635,000	0	604,782	30,218
Carbon and graphite products.....	13	161,472	0	86,958	14,514
Allied products:					
Nitrogen.....	14	37,000	0	0	37,000
Potash.....	14	16,453	0	0	16,453
Fertilizer.....	14	N	0	0	N
Total.....		6,781,950	3,407,228	2,342,685	1,032,046
1928					
Electrolytic:					
Aluminum ¹	2	2,665,000	2,330,930	0	274,070
Copper ²	3	868,631	388,766	2,363	507,502
Zinc.....	4	628,380	580,360	0	48,011
Cadmium.....	5	2,001	1,794	0	207
Magnesium.....	5	5,308	4,777	0	531
Chlorine and caustic soda ³	6	N	N	0	N
Electrothermal:					
Electric furnace steel ⁴	7	648,000	0	648,000	(⁵)
Electric furnace ferroalloys.....	8	N	0	N	N
Brass and other nonferrous alloys ⁶	9	N	0	N	N
Artificial abrasives.....	11	92,706	0	89,267	3,439
Calcium carbide.....	12	N	0	N	N
Carbon and graphite products.....	13	111,521	0	94,511	17,010
Allied products:					
Nitrogen.....	14	77,000	0	0	77,000
Potash.....	14	22,009	0	0	22,009
Fertilizer.....	14	N	0	0	N
Total.....		5,080,558	3,306,636	834,141	940,779

TABLE 1.—Consumption of electric energy in electrochemical, electrometallurgical, and allied industries, United States, 1926-36—Continued.

[In thousands of kilowatt hours]

Principal product	Section	Consumption of electric energy			
		Total	Process		Motor and lighting
			Electrochemical	Electrothermal	
1	2	3	4	5	6
1929					
Electrolytic:					
Aluminum ¹	2	2,791,000	2,495,930	0	295,070
Copper ²	3	1,065,915	463,192	2,568	600,155
Zinc.....	4	620,601	548,927	0	71,764
Cadmium.....	5	2,445	2,363	0	282
Magnesium.....	5	9,084	8,170	0	908
Chlorine and caustic soda ³	6	1,049,351	917,87	0	131,481
Electrothermal:					
Electric furnace steel ⁴	7	770,000	0	770,000	(⁵)
Electric furnace ferroalloys.....	8	1,391,000	0	1,324,762	66,238
Brass and other nonferrous alloys ⁶	9	N	0	N	N
Artificial abrasives.....	11	98,114	0	94,613	3,501
Calcium carbide.....	12	710,000	0	678,190	31,810
Carbon and graphite products.....	13	108,059	0	89,053	19,006
Allied products:					
Nitrogen.....	14	208,000	0	0	208,000
Potash.....	14	22,119	0	0	22,119
Fertilizer.....	14	140,000	0	0	140,000
Total.....		8,965,978	4,436,452	2,957,186	1,592,334
1930					
Electrolytic:					
Aluminum ¹	2	2,701,000	2,414,080	0	286,910
Copper ²	3	772,965	343,018	2,518	427,429
Zinc.....	4	517,633	490,563	0	57,070
Cadmium.....	5	2,859	2,550	0	309
Magnesium.....	5	5,596	5,096	0	500
Chlorine and caustic soda ³	6	950,778	822,794	0	127,984
Electrothermal:					
Electric furnace steel ⁴	7	508,000	0	508,000	(⁵)
Electric furnace ferroalloys.....	8	1,266,000	0	1,203,714	62,286
Brass and other nonferrous alloys ⁶	9	N	0	N	N
Artificial abrasives.....	11	74,465	0	72,074	2,391
Calcium carbide.....	12	N	0	N	N
Carbon and graphite products.....	13	91,335	0	72,900	18,435
Allied products:					
Nitrogen.....	14	180,000	0	0	180,000
Potash.....	14	23,800	0	0	23,800
Fertilizer.....	14	142,000	0	0	142,000
Total.....		7,236,431	4,048,060	1,861,206	1,327,165
1931					
Electrolytic:					
Aluminum ¹	2	2,023,000	1,813,170	0	200,830
Copper ²	3	535,401	230,547	1,396	313,458
Zinc.....	4	315,954	280,714	0	35,210
Cadmium.....	5	1,187	1,062	0	125
Magnesium.....	5	5,806	5,225	0	580
Chlorine and caustic soda ³	6	918,078	788,498	0	129,580
Electrothermal:					
Electric furnace steel ⁴	7	331,000	0	331,000	(⁵)
Electric furnace ferroalloys.....	8	784,000	0	746,667	37,333
Brass and other nonferrous alloys ⁶	9	N	0	N	N
Artificial abrasives.....	11	64,434	0	62,884	1,550
Calcium carbide.....	12	405,000	0	385,714	19,286
Carbon and graphite products.....	13	95,207	0	77,736	17,471
Allied products:					
Nitrogen.....	14	149,000	0	0	149,000
Potash.....	14	26,741	0	0	26,741
Fertilizer.....	14	94,000	0	0	94,000
Total.....		5,748,807	3,106,246	1,605,397	1,034,164

TABLE 1.—Consumption of electric energy in electro-chemical, electrometallurgical, and allied industries, United States, 1926-36—Continued.

[In thousands of Kilowatt hours]

Principal product	Section	Consumption of electric energy			
		Total	Process		Motor and lighting
			Electro-chemical	Electro-thermal	
1	2	3	4	5	6
1932					
Electrolytic:					
Aluminum ¹	2	1,215,000	1,085,130	0	129,870
Copper ²	3	316,224	105,358	1,098	209,768
Zinc.....	4	91,381	80,759	0	10,622
Cadmium.....	5	861	764	0	97
Magnesium.....	5	7,917	7,125	0	792
Chlorine and caustic soda ³	6	756,400	664,570	0	121,821
Electrothermal:					
Electric furnace steel ⁴	7	193,000	0	193,000	(⁵)
Electric furnace ferro-alloys.....	8	450,000	0	428,571	21,429
Brass and other nonferrous alloys ⁶	9	N	0	N	N
Artificial abrasives.....	11	33,290	0	32,734	556
Calcium carbide.....	12	N	0	N	N
Carbon and graphite products.....	13	60,560	0	47,609	12,870
Allied products:					
Nitrogen.....	14	158,000	0	0	158,000
Potash.....	14	24,346	0	0	24,346
Fertilizer.....	14	64,000	0	0	64,000
Total.....		3,400,979	1,943,71	5,708,093	754,171
1933					
Electrolytic:					
Aluminum ¹	2	1,031,000	916,080	0	114,920
Copper ²	3	281,179	84,466	1,331	195,382
Zinc.....	4	340,364	314,547	0	25,817
Cadmium.....	5	2,554	2,278	0	276
Magnesium.....	5	14,349	12,914	0	1,435
Chlorine and caustic soda ³	6	1,035,838	900,042	0	135,796
Electrothermal:					
Electric furnace steel ⁴	7	319,000	0	319,000	(⁵)
Electric furnace ferro-alloys.....	8	708,000	0	674,286	33,714
Brass and other nonferrous alloys ⁶	9	N	0	N	N
Artificial abrasives.....	11	33,407	0	32,497	910
Calcium carbide.....	12	330,000	0	304,762	15,238
Carbon and graphite products.....	13	84,427	0	67,886	16,541
Allied products:					
Nitrogen.....	14	211,000	0	0	211,000
Potash.....	14	35,941	0	0	35,941
Fertilizer.....	14	84,000	0	0	84,000
Total.....		4,501,059	2,230,327	1,390,762	870,970
1934					
Electrolytic:					
Aluminum ¹	2	914,000	716,482	0	197,518
Copper ²	3	288,421	100,486	372	187,563
Zinc.....	4	313,283	270,577	0	42,706
Cadmium.....	5	3,368	2,899	0	469
Magnesium.....	5	42,496	38,248	0	4,250
Chlorine and caustic soda ³	6	1,151,258	982,753	0	168,505
Electrothermal:					
Electric furnace steel ⁴	7	367,000	0	367,000	(⁵)
Electric furnace ferro-alloys.....	8	788,000	0	750,476	37,524
Brass and other nonferrous alloys ⁶	9	267,157	0	93,515	193,642
Artificial abrasives.....	11	73,504	0	58,392	15,112
Calcium carbide.....	12	N	0	N	N
Carbon and graphite products.....	13	134,909	0	108,002	26,907
Allied products:					
Nitrogen.....	14	230,000	0	0	230,000
Potash.....	14	49,460	0	0	49,460
Fertilizer.....	14	96,000	0	0	96,000
Total.....		4,738,858	2,111,445	1,377,757	1,249,656
1935					
Electrolytic:					
Aluminum ¹	2	1,402,000	1,128,967	0	273,033
Copper ²	3	443,378	161,169	514	281,695
Zinc.....	4	480,823	416,058	0	64,765
Cadmium.....	5	3,866	3,366	0	500
Magnesium.....	5	42,412	38,171	0	4,241

TABLE 1.—Consumption of electric energy in electro-chemical, electrometallurgical, and allied industries, United States, 1926-36—Continued.

[In thousands of Kilowatt hours]

Principal product	Section	Consumption of electric energy			
		Total	Process		Motor and lighting
			Electro-chemical	Electro-thermal	
1	2	3	4	5	6
1935—Continued					
Electrolytic—Continued.					
Chlorine and caustic soda ¹	6	1,350,945	1,171,796	0	179,149
Electrothermal:					
Electric furnace steel ⁴	7	516,000	0	516,000	(⁵)
Electric furnace ferro-alloys.....	8	1,248,000	0	1,188,571	59,429
Brass and other nonferrous alloys ⁶	9	349,664	0	119,965	229,699
Artificial abrasives.....	11	73,254	0	54,273	18,981
Calcium carbide.....	12	464,000	0	441,905	22,095
Carbon and graphite products.....	13	156,394	0	124,933	31,461
Allied products:					
Nitrogen.....	14	266,000	0	0	266,000
Potash.....	14	68,631	0	0	68,631
Fertilizer.....	14	108,000	0	0	108,000
Total.....		6,973,387	2,919,527	2,446,161	1,607,699

Principal product	Section	Consumption of electric energy				Ratio of total (col. 3), 1936 to 1929 (per cent)
		Total	Process		Motor and lighting	
			Electro-chemical	Electro-thermal		
1	2	3	4	5	6	7
1936						
Electrolytic:						
Aluminum ¹	2	2,597,000	2,217,367	0	379,633	93.0
Copper ²	3	651,317	282,856	633	367,828	61.1
Zinc.....	4	514,895	445,876	0	69,019	83.0
Cadmium.....	5	3,916	3,275	0	641	148.1
Magnesium.....	5	39,033	35,130	0	3,903	429.7
Chlorine and caustic soda ³	6	1,568,415	1,375,179	0	193,236	149.5
Electrothermal:						
Electric furnace steel ⁴	7	743,000	0	743,000	(⁵)	96.5
Electric furnace ferro-alloys.....	8	1,752,000	0	1,668,571	83,429	126.0
Brass and other nonferrous alloys ⁶	9	415,835	0	149,466	266,369	N
Artificial abrasives.....	11	87,357	0	65,459	21,898	80.0
Calcium carbide.....	12	550,000	0	523,810	26,190	77.5
Carbon and graphite products.....	13	195,663	0	161,864	33,799	181.1
Allied products:						
Nitrogen.....	14	288,000	0	0	288,000	138.5
Potash.....	14	83,710	0	0	83,710	378.5
Fertilizer.....	14	119,000	0	0	119,000	85.0
Total.....		9,609,141	4,359,683	3,312,833	1,936,625	106.9

N denotes data are not available.
Data partly estimated. For explanation of certain exclusions, inclusions, and estimates see tables in sections referred to.

¹ Includes mining of domestic ore, production of primary ingot from domestic and imported ore, and fabrication of both imported and domestic ingot, sheet, etc. Includes estimates covering the small proportion consumed in fabricating plants operated by companies not associated with the major producers.

² Includes energy used in associated mining, milling, and smelting activities of 1 company in Montana and 1 in Arizona. Consumption includes energy used in the production of gold, silver, copper oxide, white lead, white metals and other metallic pigments, tin products, solder metal, arsenic, acid, phosphate fertilizers, and other products not separately reported.

³ Includes caustic potash, metallic sodium, electrolytic soda ash, and hydrogen peroxide.

⁴ Small amounts of energy for motor and lighting loads, associated with these operations are neglected.

⁵ Includes melting, founding, or fabricating copper, brass, or bronze.

N denotes data are not available.

Data partly estimated. For explanation of certain exclusions, inclusions, and estimates see tables in sections referred to.

¹ Includes mining of domestic ore, production of primary ingot from domestic and imported ore, and fabrication of both imported and domestic ingot, sheet, etc. Includes estimates covering the small proportion consumed in fabricating plants operated by companies not associated with the major producers.

² Includes energy used in associated mining, milling, and smelting activities of 1 company in Montana and 1 in Arizona. Consumption includes energy used in the production of gold, silver, copper oxide, white lead, white metals and other metallic pigments, tin products, solder metal, arsenic, acid, phosphate fertilizers, and other products not separately reported.

³ Includes caustic potash, metallic sodium, electrolytic soda ash, and hydrogen peroxide.

⁴ Small amounts of energy for motor and lighting loads, associated with these operations are neglected.

⁵ Includes melting, founding, or fabricating copper, brass, or bronze.

electric energy in electro-
chemical and allied industries,
Continued.

(Kilowatt hours)

Consumption of electric energy			
Total	Process		Motor and lighting
	Electro-chemical	Electro-thermal	
3	4	5	6
1,350,945	1,171,706	0	179,140
516,000	0	516,000	(*)
1,248,000	0	1,188,571	59,429
349,664	0	119,965	229,699
73,254	0	54,273	18,981
464,000	0	441,908	22,092
156,394	0	124,933	31,461
265,000	0	0	265,000
68,631	0	0	68,631
108,000	0	0	108,000
8,973,387	2,919,527	2,446,161	1,607,699

Consumption of electric energy

Consumption of electric energy			
Process		Motor and lighting	Ratio of total (col. 3), 1936 to 1929 (percent)
Electro-chemical	Electro-thermal		
4	5	6	7
2,217,367	0	379,633	93.0
282,856	633	367,828	61.1
445,876	0	69,019	83.0
3,275	0	641	148.1
38,130	0	3,903	429.7
1,375,179	0	193,236	149.5
0	743,000	(*)	96.5
0	1,668,571	83,429	126.0
835	0	149,466	266,369
357	0	65,439	21,898
0	529,810	26,190	77.5
663	0	161,664	33,799
0	0	288,000	138.5
710	0	83,710	378.5
0	0	119,000	85.0
141	4,359,683	3,312,633	1,936,625

entiable.
For explanation of certain exclu-
sions see tables in sections referred

metallurgical ore, production of primary
metallurgical ore, and fabrication of both
sheet, etc. Includes estimates
consumed in fabricating plants
associated with the major producers.
associated mining, milling, and
company in Montana and 1 in
cludes energy used in the produc-
tion of white lead, white metal
products, solder metal, arsenic,
and other products not separately

metallurgical sodium, electrolytic soda
for motor and lighting loads,
ions are neglected.
ing, or fabricating copper, brass,

TABLE 2.—Supply of electric energy in certain industries, United States, 1928-36

[Includes aluminum, copper, zinc, cadmium, magnesium, brass, artificial abrasives, carbon and graphitized products, and potash. In thousands of kilowatt-hours]

Year	Generated				Purchased	Sold	Interchanged		Lost and unaccounted for	Consumed
	Hydro	Steam	Internal combustion	Total			Received	Delivered		
1	2	3	4	5	6	7	8	9	10	11
1928	1,715,541	387,424	0	2,102,965	2,425,711	22,446	4,643	83,779	61,538	4,365,556
1929	1,950,500	526,496	0	2,476,996	2,524,092	31,943	5,680	176,358	80,840	4,717,627
1930	1,832,154	313,836	260	2,146,250	2,280,777	15,444	40,200	197,942	64,188	4,189,653
1931	1,576,541	139,560	522	1,716,623	1,639,610	8,522	85,730	314,468	51,244	3,067,729
1932	1,239,891	101,751	879	1,342,521	671,387	4,665	90,719	301,890	48,493	1,749,579
1933	1,334,702	116,237	9	1,450,948	839,650	8,336	255,069	661,149	52,961	1,823,221
1934	1,354,526	290,312	886	1,645,724	1,088,989	3,338	208,648	779,614	53,809	2,106,600
1935	1,568,151	365,437	2,110	1,935,698	1,577,095	6,320	220,376	644,328	62,079	3,020,442
1936	2,244,543	417,804	7,441	2,669,788	2,251,453	17,397	24,365	251,122	88,361	4,588,726

NOTE.—For explanation of certain exclusions and inclusions, see detailed tables in sections 2 to 14.

TABLE 3.—Cost of power related to price of product

[Power costs of 5 to 15 percent of selling price are shown in bold type]

Product	Sec- tion	Unit of measure	Unit selling price ¹	Unit electric energy require- ments ²	Ratio of electric energy cost to selling price of finished product at selected unit costs—percent													Energy costs of representa- tive pro- ducers
					Average unit cost of energy in cents per kilowatt hour													
					0.1	0.2	0.25	0.3	0.35	0.4	0.5	0.6	0.7	0.8	0.9	1.0		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
			<i>Dollars</i>	<i>Kilo- watt- hours</i>													<i>Cents per kilowatt- hour</i> (³)	
Electrolytic:																		
Aluminum.....	2	Short ton.....	400.00	23,985	6.0	12.0	15.0	18.0	21.0	24.0	30.0	36.0	42.0	48.0	54.0	60.0		
Copper (electrolytic leach- ing).....	3	do.....	220.00	2,820	1.3	2.6	3.2	3.8	4.5	5.1	6.4	7.7	9.0	10.3	11.5	12.8	0.65	
Copper (electrolytic refin- ing).....	3	do.....	220.00	367	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.3	1.5	1.7	0.70	
Zinc.....	4	do.....	100.00	3,714	3.7	7.4	9.3	11.1	13.0	14.9	18.6	22.3	26.0	29.7	33.4	37.1	0.25, 0.5	
Magnesium.....	5	do.....	600.00	20,000	3.3	6.7	8.3	10.0	11.7	13.3	16.7	20.0	23.3	26.7	30.0	33.3	(³)	
Sodium (metallic).....	5, 6	Short ton of metallic sodium and 3,063 pounds of chlorine.	\$ 376.28	14,400	3.8	7.7	9.6	11.5	13.4	15.3	19.1	23.0	26.8	30.6	34.4	38.3	0.35	
Chlorine and caustic soda.	6	Short ton of caustic soda and 1,770 pounds of chlorine.	\$ 109.16	3,009	2.2	5.5	6.9	8.3	9.6	11.0	13.8	16.5	19.3	22.1	24.8	27.6	0.35	
Electrothermal:																		
Ferromanganese 80 per- cent.....	8	Long ton.....	102.50	7,280	7.1	14.2	17.8	21.3	24.9	28.4	35.5	42.6	49.7	56.8	63.9	71.0	(³)	
Ferrosilicon 50 percent.....	8	do.....	66.50	6,160	8.9	17.7	22.2	26.6	31.0	35.5	44.3	53.2	62.0	70.9	80.0	88.6	0.3, 0.5	
Fused alumina.....	11	Short ton.....	56.04	3,143	5.6	11.2	14.0	16.8	19.6	22.4	28.0	33.7	39.3	44.9	50.5	56.1	0.35	
Silicon carbide.....	11	do.....	72.93	9,340	12.9	25.7	32.2	38.6	45.0	51.4	64.3	77.2	90.0	102.9	115.8	128.6	0.35	
Calcium carbide.....	12	do.....	100.00	3,150	3.2	6.3	7.9	9.4	11.0	12.6	15.8	18.9	22.0	25.2	28.4	31.5	0.35	
Allied:																		
Anhydrous ammonia.....	14	do.....	90.00	1,530	1.7	3.4	4.2	5.1	6.0	6.8	8.5	10.2	11.9	13.6	15.3	17.0	0.3-0.5	

¹ Represents manufacturers' prices as of Jan. 3, 1938 from prices pub-
lished by the "Oil Paint and Drug Reporter," "Engineering and Mining
Journal," and "Industrial and Engineering Chemistry" except as noted.
² Represents all energy directly chargeable to each product for the
operation specified, including electrolytic, electrothermal, motor, light-
ing, and incidental loads.
³ Representative data are not available.

⁴ Represents energy directly chargeable to process only.
⁵ Based on a price of 15.5 cents per pound for metallic sodium and 2.15
cents per pound for chlorine.
⁶ Based on a price of 2.7 cents per pound for caustic soda (76 percent
solid) and 2.15 cents per pound for chlorine.
⁷ Average value of United States and Canadian production of crude
material during 1936, from data published by the U. S. Bureau of Mines.

In 1936 the manufacturing industries covered by this report consumed about 11,914,000,000 kw.-hr. of electric energy. Including various related electro-process operations on which reports were not obtained (electroplating, etc.), the total was probably 12,500,000,000 kw.-hr., equivalent to more than 10 per cent of the total energy generated for public use that year. These figures include 105,000,000 kw.-hr. for electric furnace steel and 2,200,000,000 kw.-hr. for electric heat treating on which adequate data for previous years could not be obtained. Excluding these operations, the total for the industries on which reasonably complete information could be obtained was 9,609,141,000 kw.-hr. of energy in 1936. Of this, 4,359,683,000 kw.-hr. were used for electrolytic processes and 3,312,833,000 kw.-hr. for electrothermal processes. The balance of 1,936,625,000 kw.-hr. was for motors and lighting, but also included the total requirements for chemical nitrogen, potash and inorganic fertilizers.

Table 1 shows the consumption of electric energy in these industries by years from 1926 to 1936 inclusive.

The load characteristics of these highly specialized industries are very different from those of other industrial operations. There are three general types: the electrolytic loads, which are inherently continuous and almost uniform; the arc-furnace loads, which are subject to interruption and also to wide and sometimes violent fluctuations in demand; and the resistor furnace loads, which are typically steady during the hours of operation.

Controlling Demand Fluctuations

The electrolytic and resistor furnace processes are highly desirable from the viewpoint of the supplying electric utility. For the arc furnace, special control methods and arrangements of feeder circuits have been devised to keep the demand fluctuations within bounds and make it possible for the central station to supply the furnace load without undue interference with the regulation of service to other customers.

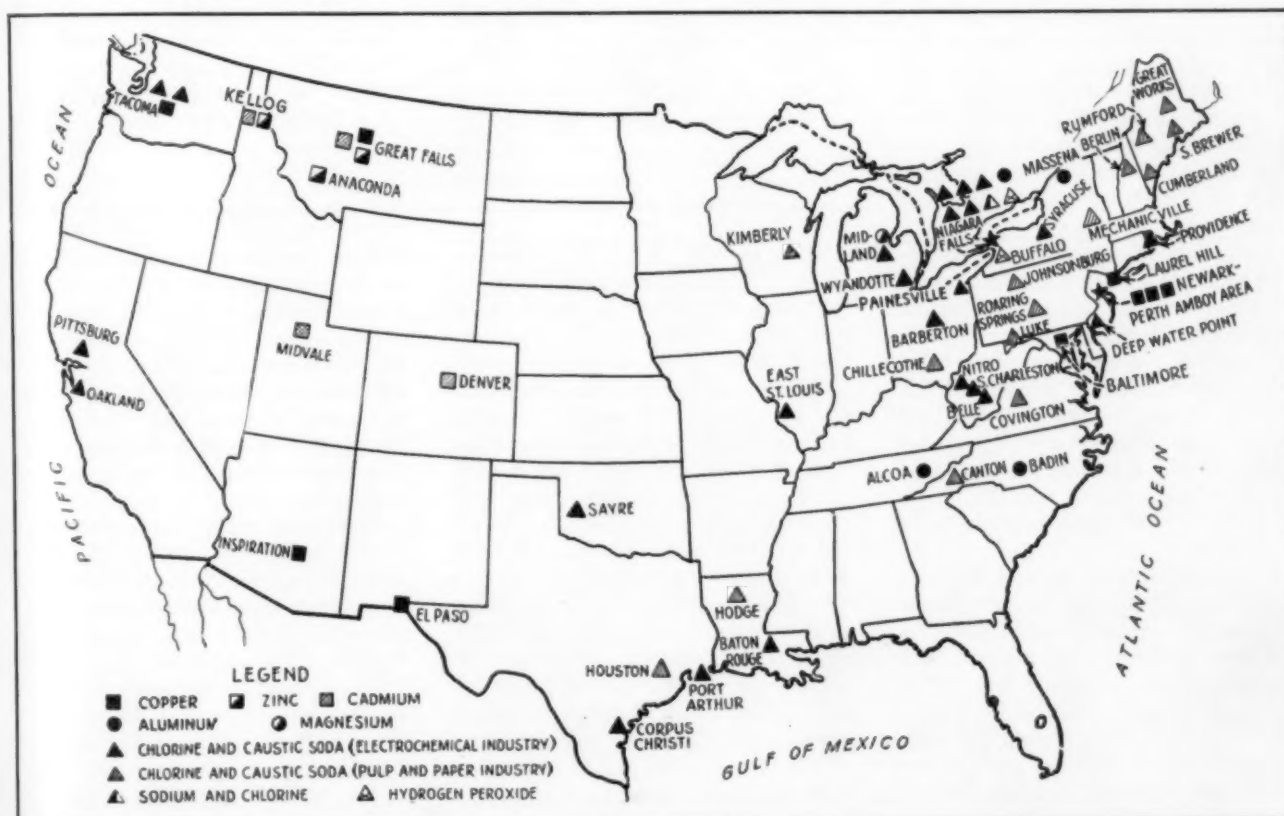
The electrolytic demand can be varied intentionally between certain limits by adjusting the voltage of the direct-current supply, without mate-

rially affecting the efficiency of the cells. It is thus possible either to operate at a nearly uniform demand with a load factor approaching 100 per cent, or to obtain other characteristics if desired. One of the larger producers of electrolytic chlorine has installed automatic control for this purpose. (See J. V. Alfried, Jr., "Economies Resulting From Improved Load Regulation," *Chem. & Met.*, April, 1932, pp. 209-11.)

The possibility of utilizing large quantities of low-cost seasonal or "secondary" power is suggested by such examples of load control and also by several electric furnace operations where arrangements have been made for the use of secondary power at low rates for a portion of their requirements.

A further characteristic of the electrochemical and many of the electrothermal loads that may assist in fitting their requirements to available low-cost power is that they are typically made up of sequences of comparatively small equipment units whose output is not limited by other plant operations. Small-capacity plants may therefore show production costs

Fig. 2—Principal electrolytic plants in the United States, 1937—their location and the most important product made by each



not very different from larger ones, and in general the operations are more flexible and the rates of output can be varied with smaller losses in efficiency and less interference with operating schedules than in most large industries.

In the electro-processing industries with their enormous power requirements, the cost of electric power is necessarily a high proportion of the price of the resulting product. For this reason the industries have sought and found locations where power could be generated or purchased cheaply.

Table 3 shows the relation of the cost of electric energy to recently prevailing prices for some of these products, at assumed energy rates ranging from 1 mill to 1 cent per kw.-hr. Where available, actual average energy rates known to have been paid by representative producers are given in column 18. In considering these actual rates, it should be noted that average unit costs of generated energy and average unit prices of purchased energy differ according to the location and also according to the amount used and the characteristics of the particular plant load.

It is seen that in many cases the typical price paid for electric energy happens to result in a ratio of energy costs not far from 10 per cent of the product price or value. Rates providing a lower ratio than this are naturally acceptable to the industry but successful commercial practice indicates that so far this has not been absolutely necessary. Lower rates would presumably encourage more extensive development; with some exceptions higher rates apparently prevented any development.

In general these ratios of energy cost to product price are several times as large as in other manufacturing industries, where the power cost is often of the order of 2 per cent. But other factors must be considered, including the cost of raw materials and labor, transportation and marketing facilities, and especially the value of the electric process in reducing other costs and in obtaining co-products or byproducts.

The electrochemical and electro-metallurgical industries have been marked by constant change throughout their relatively brief history. Research workers have found these fields extremely fruitful and have steadily added to the list of products and processes that contribute to modern needs and affect the consumption of

Table 4—Unit Requirements for Electric Energy

(Per short ton unless otherwise noted.)

Product	Average consumption of electric energy, kilowatt-hours	
	Total	Electrolytic or electrothermal
Aluminum.....	23,988	21,021
Copper.....	367	249
Zinc.....	3,714	3,381
Cadmium.....	2,342	2,048
Magnesium.....		16,000-20,000
Chlorine and caustic soda (per ton of chlorine).....	3,400	3,006
Cast and alloy iron (per ton of metal melted):		
Duplex.....		50-115
Batch-cold melt.....		500-600
Cast steel:		
Duplex.....		75-150
Batch-cold melt.....		500-700
Steel ingots (per long ton):		
Duplex.....		100-210
Batch-cold melt—tool and special alloys.....		550-750
Stainless and automotive.....		525-650
Straight carbon.....		500-550
Ferrosilicon, 15 per cent silicon.....		4,000-5,000
Ferrosilicon, 50 per cent silicon.....		5,000-6,000
Ferrosilicon, 70 per cent silicon.....		6,000-6,500
Ferromanganese, 80 per cent manganese.....		6,000-7,000
Silicomanganese, 70 per cent manganese.....		4,500-6,500
Ferrocromium, 70 per cent chromium.....		6,000-8,000
Ferro-tungsten, 70-75 per cent tungsten:		
Smelting.....		4,200
Refining.....		3,400
Total.....		7,600
Ferromolybdenum, 70 per cent molybdenum.....		8,000-9,000
Ferrovanadium, 35-45 per cent vanadium.....		4,500-8,000
Ferro-uranium, 35-50 per cent uranium.....		7,000
Core type induction furnaces (per ton of metal melted):		
Red brass.....		252
Yellow brass 2:1.....		195
Bronze.....		285
Pure copper.....		310
Zinc.....		90
Nickel-silver.....		275
Coreless type induction furnaces:		
Special steels.....		660
Nickel-silver.....		340
Rocking hearth indirect arc furnaces:		
Brass, general.....		250-300
Artificial abrasives:		
Silicon carbide.....	9,380	8,495
Fused alumina.....	3,143	2,809
Calcium carbide.....	3,150	3,000
Graphitized products.....		3,000-8,000
Nitrogen—Existing synthetic ammonia plants in United States at capacity operation (per ton of contained nitrogen).....	1,530	
Nitrogen—Synthetic ammonia using electrolytic hydrogen.....	15,000	
Fertilizer:		
Dry mixing.....	8.0	
Required superphosphate (0.44 tons).....	9.5	
Total complete fertilizer.....	17.5	
Phosphoric acid (electric furnace) (per ton of contained P ₂ O ₅).....		4,500-5,500

electric energy. These developments are continuing on a broader base.

During the past eight years there have been striking results from research in the field of powder metallurgy and in the production of rare and minor metals in electric furnaces and electrolytic cells. The U. S. Bureau of Mines and other public and private agencies are developing new processes, utilizing electric energy and domestic raw materials. One of these obtains manganese by electrolysis from domestic low-grade ores; another obtains alumina silica and potash from domestic leucite ore by an electric furnace method. Carbon bisulphide, silicon, fused silica, fused quartz, phosphoric acid and phosphorus are among the electric furnace materials whose combined pro-

duction has as yet required relatively small quantities of electric power. Phosphates have assumed considerable significance within the last three years. Decreasing power rates may have an important bearing on the quantities of these and other materials produced electrically and therefore on the amount of electric energy required.

From past experience and present outlook it appears certain that even without further new developments, the total electric requirements of this particular group of industries will expand at a rate somewhat greater than that of general industrial activity, because requirements for the products themselves are clearly increasing at rates higher than the average. Added to this underlying tendency will be

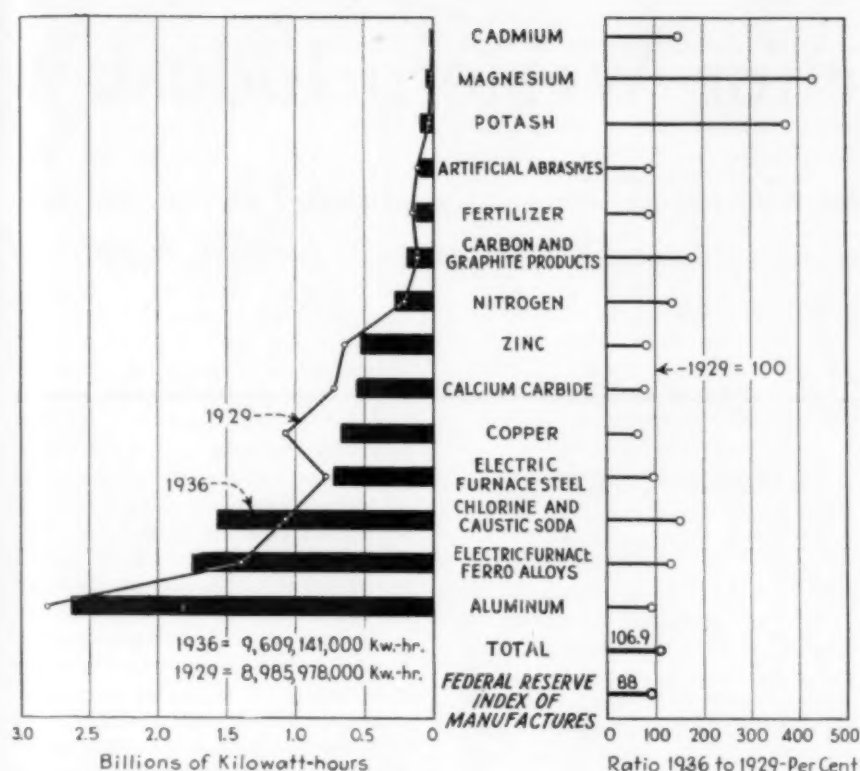


Fig. 3—Consumption of electrical energy—United States—1929–1936

the potentially much larger incremental use of electric energy where changing conditions make the electro-processes more advantageous or less costly than older methods, and perhaps equally great increments obtained from new products and processes now in various stages of development. Such compounding of growth factors should be recognized in providing for the national power requirements of the near future, particularly in regions where the availability of raw materials and low-cost electric power are favorable to these developments.

In the Pacific Northwest with its large and immediate possibilities of low-cost hydroelectric energy, for example, there is a definite possibility of aluminum production from foreign ores delivered by cargo shipment on the Columbia River or on Puget Sound. The availability of iron ore, of iron and steel scrap, and of coking coal, suitable for electric furnace production, and a relatively small load capacity now installed, indicate that electric production of iron and steel alloys may be commercially feasible in the near future. Widespread deposits of manganese, chromium and other ores suggest the possibility of ferro-alloy production. Extensive resources of phosphate rock in Idaho, Wyoming, Utah and Mon-

tana are available for the manufacture of phosphoric acid and phosphates. More immediate prospects for the development of sodium chlorate and of calcium carbide are also to be noted.

Magnesites in California and alunites in Utah may be used for the production of electrolytic magnesium and electric furnace potash. The ability to make potassium nitrate from potassium chloride and nitrogen peroxide (derived from ammonia), to-

gether with the potential need for additional ammonia for fertilizer use, indicate that new capacity for synthetic ammonia may be expected; perhaps utilizing power from Boulder Dam.

The principal factors that will affect future power requirements for the electro-processing industries have been studied in their relation to estimates of the annual consumption to be anticipated within a period of about five years. These estimates, given in Table 5, are based on past growth, on probable changes in the markets for materials in their older uses, on new uses and new processes that are known to be of prospective importance, and on the continued availability of low-cost electric energy in certain regions.

Extraordinary influences such as those of a war or a major change in the business cycle, have been excluded from consideration as being impossible to evaluate usefully either in magnitude or in time of occurrence. The high levels recorded in the first nine months of 1937 have been discounted together with the sharp curtailment of power consumption which began in the last quarter of the same year. The estimates, therefore, represent extensions of the normal trend modified according to certain factors that have already appeared or are definitely indicated for the near future.

The problem of estimating these future power requirements is not to establish whether they will occur, but rather to indicate their approach sufficiently far in advance to permit the orderly development of power resources to meet the increased needs.

Table 5—A Forecast of the Consumption of Electric Energy Per Year

Product	Past requirements ¹	Future requirements probable within 5 years	Ratio to past requirements in percent
	Kilowatt-hours	Kilowatt-hours	
Aluminum.....	2,597,000,000	3,600,000,000	139
Copper.....	2,600,000,000	2,500,000,000	96
Zinc (electrolytic).....	515,000,000	850,000,000	165
Magnesium.....	39,000,000	100,000,000	256
Chlorine and caustic soda (electrolytic).....	1,568,000,000	1,900,000,000	121
Electric furnace iron.....	105,000,000	200,000,000	190
Electric furnace steel.....	743,000,000	1,100,000,000	143
Electric furnace ferro-alloys.....	1,752,000,000	2,500,000,000	143
Heat treating.....	2,200,000,000	3,000,000,000	136
Artificial abrasives.....	87,000,000	116,000,000	133
Calcium carbide.....	550,000,000	1,100,000,000	200
Carbon and graphitized products.....	196,000,000	300,000,000	153
Nitrogen.....	288,000,000	375,000,000	130
Potash.....	84,000,000	140,000,000	167
Total.....	¹ 13,324,000,000	17,781,000,000	133

¹ Year 1936; except for copper, where 1929 is used because it is the only year for which complete data on power consumed in mining, milling, smelting, and refining of copper are available. For this reason and also because energy requirements for cadmium, brass, and inorganic fertilizers are not included, the total shown can not be reconciled with the figure of 11,914,000,000 kilowatt-hours given for 1936 on p. 467.

More Power for Western Industry

Politics, competition and diplomacy play an increasingly important part in the huge developments that mean power in abundance, low rates, adequate distribution facilities, flood control, and better navigation for the Far West.

IN ADDITION TO the basic characteristics of abundance and low price, the power situation on the Pacific Coast has developed several new distinctions in the 3-year interval since *Chem. & Met.* made its last comprehensive survey in August, 1935. Partial fruition of the federal program of reclamation, flood control, navigation and power development has introduced the components of politics and competition plus a generous element of poker-playing diplomacy. Familiarity with these new variants, as well as with rates and resources such as outlined in 1935, is essential for the industrialist who looks to the Coast today as a region for profitable exploitation of a process industry in which power is an important factor.

The statistical status of the power industry in this territory can be described in one sentence: Both supply and demand reached new peaks in 1937 with a healthy surplus available for prospective users and an even greater surplus in sight for the near future (see accompanying table). Production from Boulder Dam, Bonneville and Seattle's Diablo project maintained the overproduction; these three—along with Grand Coulee and California's Central Valley project—

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will sustain it. In the meantime the prospective industrial customer is assured of a continuation of these attractive advantages: power in abundance; low rates which are concomitant with hydro generation; power availability at sites close to raw material sources due to the extensive transmission and distribution facilities; and competition between regions for large power customers.

On the other hand, a knowledge of regional attitudes, backgrounds, policies, political developments and trends as they relate to electric power is essential for final selection of a plant location. It is the purpose of this discussion to outline these briefly as they affect the natural geographic regions in the Pacific Basin.

Bonneville and Grand Coulee in the Pacific Northwest have become national synonyms for cheap power in a region where rates have long been so low as to have attracted favorable comment from President Roosevelt.

Any appraisal of the industrial opportunities offered by Bonneville will involve the presentation of certain

fundamental facts and the exploding of certain popular fallacies which have been accepted as facts. Located at the head of tidewater on the Columbia River 42 miles east of Portland, the Bonneville plant has an initial power output of 90,400 kw., two additional 52,000-kw. units in course of installation and an ultimate capacity of 504,000 kw. Marketing of the power is in the hands of a federal administrator, J. D. Ross, former superintendent of the Seattle municipal power system, a fact which may or may not have some bearing on the competitive aspects of the final Bonneville rates which were established with Federal Power Commission approval. The power is being sold on a uniform rate basis throughout the region, the charges being \$14.50 per kw.-year for primary power and \$9.50 for secondary power at the dam site and \$17.50 and \$11.50 from any point on the extensive transmission system now being erected. The dam-site rates are available to potential industrial users in minimum blocks of 2,500 kw.; power from the transmission network must be purchased through some already existing distributing agency. These rates are lower than those hitherto available through private or municipal utilities for high load factor customers. They are based upon four-sevenths of the cost of the completed \$74,000,000 project, the balance of the investment being allocated to navigation. Also the project pays no part of the \$2,000,000 tax levy it would bear under private ownership. But unless a prospective user has a continuously operating process with both a high load factor and high power factor, it might be that he could obtain electricity cheaper through the existing rate schedules of the distributing agencies than through the kilowatt-year schedules.

Because of popular misunderstanding-

Pacific Coast Power Resources, 1938

	California	Oregon	Washington	Total
Potential hydro resources*:				
Capacity of plant sites.....	6,411,455	5,137,110	11,615,617†	23,163,182
Average annual kw.....	3,991,800	4,024,006	9,437,267†	17,453,073
Energy output, M kw.-hr.....	34,966,444	35,250,276	82,670,459†	152,886,970
Installed hydro capacity, kw.....	1,704,430	281,466	796,515	2,782,411
Installed fuel capacity, kw.....	1,064,181	180,018	218,647	1,462,846
Total installed capacity, kw.....	2,768,621	461,484	1,015,212	4,245,317
Energy generated 1937, M kw.-hr....	9,598,651	1,391,715	3,727,223	14,717,589
Output capability, present capacity,				
M kw.-hr.	10,900,000	1,823,000	4,010,000	16,733,000
Output capability from Federal				
projects under construction, M kw.-hr.	5,890,000	2,375,000	7,500,000	15,765,000
Total capability of existing plants				
plus Federal projects, M kw.-hr....	16,790,000	4,198,000	11,510,000	32,498,000

* Including extensions to existing plants partially developed

† Preliminary

ing as to the ultimate community benefits which might accrue from a large reservoir of low-cost generation such as Bonneville presents, some unfortunate restrictions were written into the law which set up the Bonneville Administration. Half of the energy output is reserved until 1941 for publicly-owned or cooperative distribution systems with priority reservations in their favor thereafter. Contracts with private industry are limited to 20 years, are cancellable on 5 years' notice and may be revised at the end of any 5-year term. Obviously these restrictions were based on the fallacy that the industrial use of power would deprive small consumers in the contiguous area of the benefits of the Bonneville project, whereas such use would conceivably consume raw materials, provide employment, bring in new population and increase the domestic market for basic agricultural products. Outcome of these restrictions has been a well defined move on the part of industrially-conscious people in the region for a broad interpretation of the law and a downward revision of the rates which would encourage industrial development.

In the meantime, an extensive network of transmission lines, many of which duplicate existing facilities, is being constructed to take the power to possible customers. These will extend from Bonneville to Vancouver, Wash., thence to Portland, Eugene and Salem, Ore., to the south and Kelso, Aberdeen, Hoquiam and Centralia, Wash., to the west. Other lines will extend from the plant eastward to The Dalles, Ore., and north to Grand Coulee. The apparent philosophy of the administration is that the benefits of the project should accrue to all of the people and that these benefits can best be obtained through government ownership.

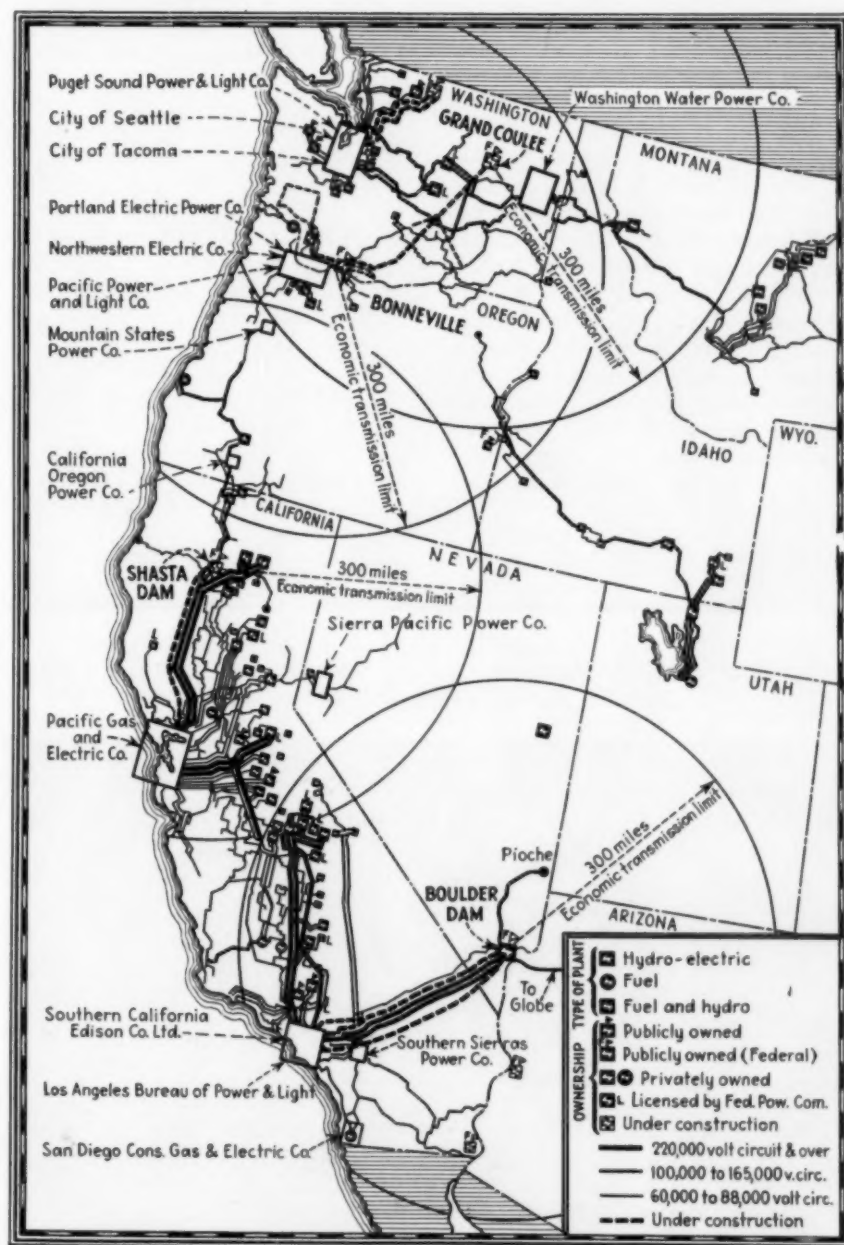
Informed and impartial observers sum up the Bonneville situation thusly: Political prescience of men and unfortunate public confusion threaten to nullify the real benefits to be derived from this great source of low cost hydro-electric energy, which is particularly valuable in a region without oil or natural gas fuel resources and where other uses are curtailing the supply of sawmill waste fuel. Pursuing the present marketing policies to their ultimate conclusion by encouraging public ownership to an extreme, imaginably could result in untold damage to the private utilities now serving the region, a course which the

public itself will hardly sanction. The marketing of this surplus power should be a mutual undertaking in which the Bonneville Administration and the existing distributing agencies can co-operate, particularly in inducing the location of industrial enterprises which would utilize valuable raw material resources, add payroll, increase employment and create new purchasing power. Should such a program fail to materialize and Bonneville power become a drug on the market, it is possible that "production for use" might be resorted to with some governmental agency engaged in basic industrial manufacture either for the army, the navy or for agriculture. Also, despite the present restrictions and reservations which surround Bonne-

ville power, it is felt that a legitimate industrial prospect could place his chips in the poker game and come out with a satisfactory agreement.

While Bonneville situation is in a state of flux, Grand Coulee is a matter of three or four years in the future. This key irrigation and power project is located 70 miles west of Spokane on the Columbia River. Its ultimate cost will be \$394,000,000 and it will provide water for irrigating 1,200,000 acres of land and the production of 7,500 million kw.-hr. of firm and 4,000 million kw.-hr. of secondary power. Of the proposed capacity of 1,650,000 kw., 315,000 kw. will be installed initially in three units. Part of the power is necessary for

(Please turn to page 495)



Manufacturing Petroleum Products

Recent visits to eight large and important Western and Gulf Coast petroleum refineries leave this observer with interesting impressions of many trends toward further chemical utilization of our abundant hydrocarbon resources.

PETROLEUM "REFINING" is getting to be somewhat of a misnomer. Perhaps some day it will be regarded as an archaic expression that had its origin in those early times when crude oil was "mined" and then "refined" so that it wouldn't explode in the old coal-oil lamps. "Black gold" was where you found it, but it had to be refined before you could cash it into the currency of the realm. Today all this is changed. The petroleum refiner is primarily a manufacturer and the crude oil and natural gas that come to his plant are just so much raw material for chemical processing. At least that is this writer's impression after recent visits to eight of this country's largest and most important refineries.

Up until the twenties, the petroleum refiner was primarily concerned with

S. D. KIRKPATRICK

Editor

Chemical & Metallurgical Engineering

the production of a few standardized products—gasoline, kerosene, fuel and lubricating oils. Chemical problems were less important than the engineering developments that increased capacity and lowered costs. To be sure there were a few people and companies that were playing around with the idea of making chemicals and other things from petroleum, but most of the industry regarded this as a questionable activity. Then about 1924 came the development of tetraethyl lead as an anti-knock compound in gasoline and this was followed a few years later with the setting up of a yardstick of octane num-

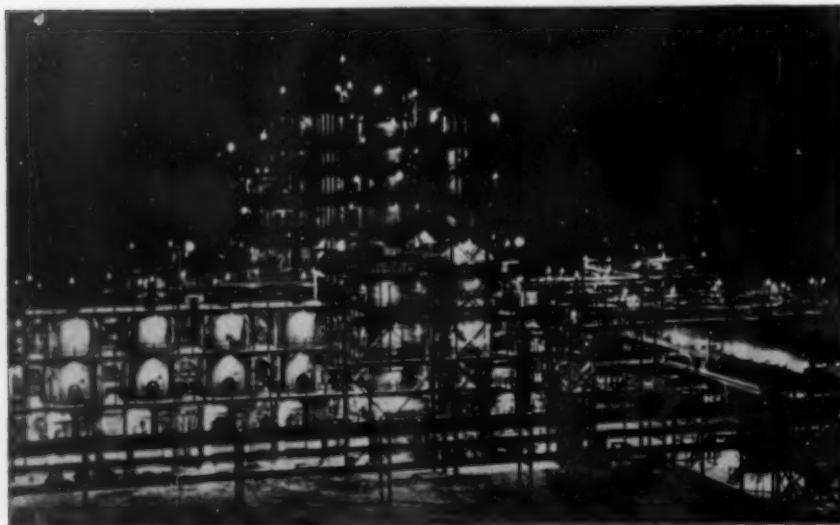
bers to measure this newly important quality. On this arbitrary scale, iso-octane was given a value of 100 and became the reference fuel for anti-knock evaluation. This hydrocarbon was then nothing more than a laboratory curiosity; so the petroleum refiner went to the chemical manufacturer and paid him \$25 per gal. for the small amounts that were needed in his testing laboratories. He never guessed that today the petroleum industry would be manufacturing millions of gallons of this same hydrocarbon and be able to sell it as 100-octane aviation fuel at little more than 25 cents—rather than \$25—per gallon.

Manufacturing Chemicals

This is only one of many striking examples of what has taken place in this industry as the emphasis has shifted toward chemical manufacturing—toward the actual production of synthetic fuels, solvents, resins and similar products. This change has been made possible largely because of the intensive study and research that have been directed toward greater knowledge of the composition of petroleum and of the nature and characteristics of its hydrocarbon constituents. When the laboratories began pulling petroleum apart and systematically accumulating fundamental physical and chemical data on the properties of the hydrocarbons, this paved the way for a tremendous advance in the refining industry.

In one plant recently visited there has been an investment of \$6,500,000 in "superfractionating" equipment where, by compression, absorption, distillation and stabilization, it is possible to separate mixtures of

An impressive sight, especially at night, is a modern petroleum processing unit that combines distillation, cracking and reforming operations with stabilizing and clay treatment of finished products



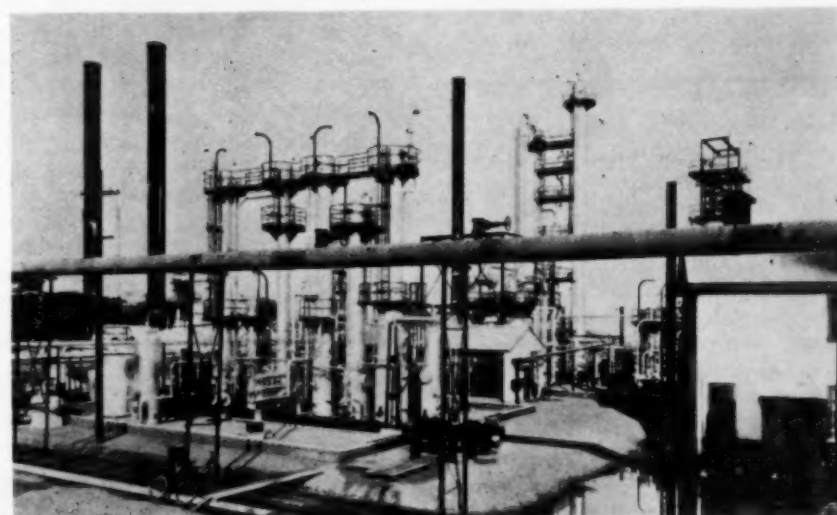
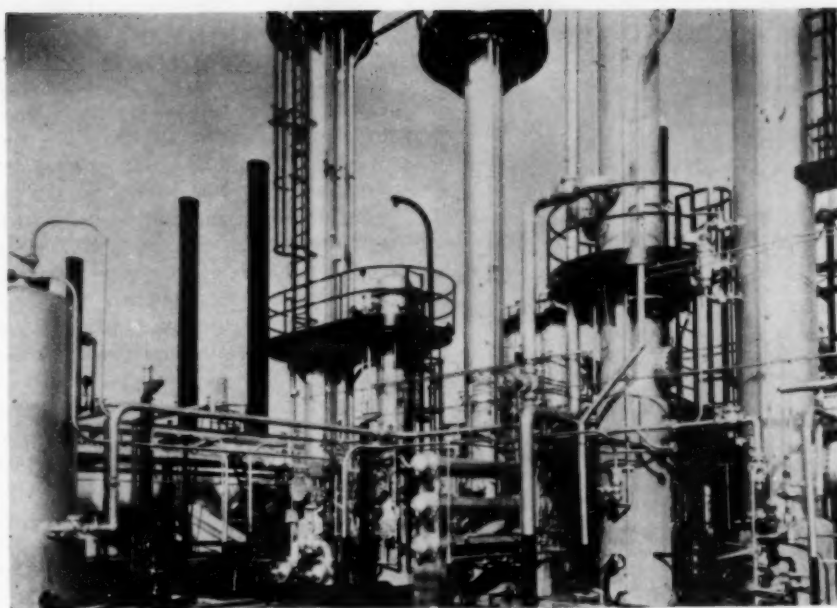
hydrocarbon gases into their pure components. The outstanding success this company has had in developing many new and improved products from petroleum is directly traceable to the purity of the raw materials, i.e., the hydrocarbon fractions so carefully obtained. Egloff, Hubner and Van Arsdell in *Chemical Reviews* for February, 1938, described a similar installation where a natural gas is being fractionated to give a propane fraction of 99 per cent purity along with 100 per cent recovery of pure isobutane, *n*-butane, isopentane and *n*-pentane.

Given raw materials of this purity, the petroleum refiner is able to manufacture chemical products as well as synthetic motor fuels. One large oil company, that incidentally employs 450 chemists and engineers in its centralized development department is now making acetone, diacetone alcohol, secondary butyl acetate, secondary butyl alcohol, methyl ethyl ketone, isopropyl alcohol, isopropyl acetate, isopropyl ether and mesityl oxide. Another long list of pure organic chemicals includes more than a dozen new compounds that are already available in laboratory quantities. Commercial development awaits only the development of suitable outlets.

Catalytic Hydrogenation

Production of such chemicals from petroleum is, of course, an infinitesimally small business as compared with the 120,000,000 gal. of crude oil that is daily processed in American petroleum refineries. The major products are still gasoline and fuel oils, but even in their production there is more and more evidence of chemical manufacture. Reference has already been made to the increasing importance of synthetic motor fuels such as iso-octane. Gaseous hydrocarbons from cracking are readily polymerized by a variety of processes as described by Professor Koehler in *Chem & Met.* last month (see pp. 412-5, August 1938). Sometimes the resulting polymers are used directly as blending agents to produce high anti-knock gasoline. Sometimes they are further processed by hydrogenation to yield mixtures of iso-octanes that are more often called synthetic fuels.

This application of high pressure catalytic hydrogenation promises to become of increasing importance. In fact, one Western refinery has just completed the construction of such a hydro plant at a cost in excess of



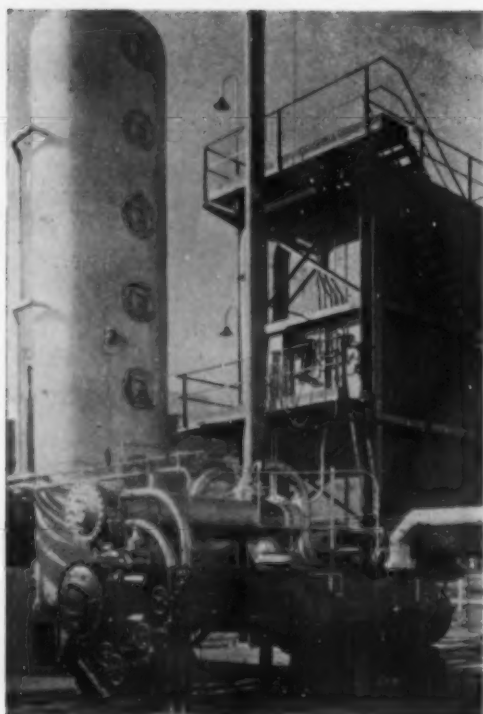
One secret of success today in the petroleum industry lies in the purity of the hydrocarbon fractions used as raw materials for chemical processing. Superfractionation supplemented by compression, absorption and stabilization, effectively separates the hydrocarbon mixtures into their pure components

\$1,000,000. Its purpose is to make synthetic aviation gasoline from the unsaturated hydrocarbons (butenes and isobutenes) obtained from its cracking stills. These are first polymerized either in the liquid phase with concentrated sulphuric acid or in a new catalytic polymer plant. They are then hydrogenated at 3,000 lb. pressure in the presence of a special catalyst adapted to the reaction of polymer hydrogenation.

Hydrogen for this process is generated by contacting a mixture of natural gas and steam with a catalyst at a high temperature. The product is a crude gas mixture of hydrogen

and carbon monoxide from which the latter must be removed by treatment with additional steam in the presence of a second catalyst that converts the CO to CO₂. The carbon dioxide is later removed by scrubbing with monoethanolamine.

The purified hydrogen is piped to three steam-driven compressors which deliver it to the so-called reaction "oven" at a pressure of 3,500 lb. per sq. in. This vessel is a vertical steel cylinder, 40 ft. high by 3 ft. inside diameter, and with walls several inches thick. Here it makes its contact with a hydrogenation catalyst which, fortunately, is



Hydrogen for catalytic hydrogenation is made by cracking a mixture of natural gas and steam in equipment like this

quite insensitive to sulphur. The mixture of the hydrogenated product and the excess hydrogen is discharged from the reaction oven, still under a pressure of over 3,000 lb., through a cooling and condensing system in which gasoline vapors are liquefied. The excess hydrogen is recycled back to the oven and after the pressure on the liquefied product is released, it finally passes to a stabilizing column to remove any remaining gaseous material. The final product so obtained is a synthetic aviation fuel of 90 to 100 octane rating, depending largely upon the character of the original charging stock.

"Coal Tar" Solvents From Oil

In addition to its specific applications in the manufacture of synthetic gasoline, this new hydro-plant is designed with a flexibility which makes it readily adaptable for the manufacture of high quality diesel and lamp oils, highly solvent thinners for paint and varnish and other special products. "Coal tar" solvents are now being produced from petroleum which contain 80 per cent or more of aromatic hydrocarbons (see *Chem. & Met.* Oct. 1937 pp. 598-601). What this might mean in case our country was drawn into a war is all too evident to those who recall the costly and often unsuccessful searches for toluol in 1917-18.

Not all, by any means, of the new plant construction in the oil industry is confined to equipment for synthetic gasoline or chemical production. In the course of these visits to eight refineries on the Gulf and West Coasts, the writer saw under construction three new plants for propane dewaxing and deasphalting of lubricating oils, as well as an equal number of solvent extraction processes using phenol, acetone-benzol and sulphur dioxide. Six large distillation and combination cracking units were being built in these refineries at an estimated total cost of \$5,000,000. New catalytic or thermal polymerization plants have been completed or were under construction this summer in five of these refineries. One of the largest of these, costing in excess of \$2,500,000, operates at temperatures slightly over 1,000 deg. F. and pressures that approach 2,000 lb. per sq. in. This plant will produce almost 5,000 bbl. per day of polymer gasoline from mixtures of byproduct C_3 and C_4 gases obtained from the cracking stills or directly from the oil fields.

One of the most ambitious construction programs was noted in Southern California where approximately \$5,000,000 is being spent in building two huge combination

cracking units that will have a total capacity of 60,000 bbl. per day. These units are equipped with seven furnaces, six of which are of the vertical tube type, each containing 200 chrome-molybdenum tubes 4 in. in diameter and 40 ft. long suspended in two banks. All are subjected to radiant heat from a fire-brick cone in the center of the vertical furnace which is fired by 12 circular gas burners at the top. An impressive sight is the control room where more than \$50,000 has been spent for automatic, recording, indicating and control instruments. This refinery is also constructing a new polymerization plant using the catalytic process, as well as new debutanizer and stabilizer units. It is one of the refineries that pioneered in the use of the new zinc chloride treating process and it is interesting to note that that operation has now been expanded to treat 7,500 bbl. per day.

"Engineer's Dream Plant" in Texas

But what has been aptly called "an engineer's dream of an oil refinery" was visited in Texas while the writer was en route to the West Coast. It is new and modern in every respect, having been built from the ground up during the past five years. The unique layout and

These extraordinarily large units, that combine all of the various steps of manufacturing, made it possible for this refinery in 1937 to process almost two per cent of the entire United States' output of crude petroleum



comprehensive character of this refinery is shown on page 476. In the foreground is the catalytic polymerization plant and next to it is the large No. 2 combination cracking unit. Then comes the power house and the original No. 1 cracking unit. A small re-run unit for processing furnace oil is shown at the right. Since this photograph was taken, construction has been practically completed on a smaller No. 3 unit designed primarily for handling heavy crude oils.

Engineers who were responsible for the original planning and actual design of this plant decided to use the largest operating units that could be built provided it was still possible to ship the towers and other integral parts of the equipment by rail. A single piece of this equipment weighed 257 tons, and at that time was the largest shipment ever made in one piece on an American railroad. By using such extraordinarily large units and combining the various steps in the process, it has been possible to produce gasoline at an unusually low cost.

Description of Equipment

The principal equipment of this refinery consists of two combination topping and cracking units that in 1937 succeeded in processing about

1.7 per cent of the entire U. S. production. Since February 1937, when the No. 2 unit was placed in operation, the two units combined have handled an average of more than 60,000 bbl. of crude oil per calendar day. A typical operation on an East Texas crude produces 53 per cent of high octane gasoline, 10 per cent of kerosene, 10 per cent of furnace oil, and 19 per cent of fuel oil, based on the crude charge.

Design of No. 1 unit was started in May 1933, construction commenced in July and the plant was put into operation in April 1934. The No. 2 unit was completed in February 1937. Some idea of their complexity may be gained from the fact that each unit combines the following equipment: crude flash towers, viscosity breaking furnaces, combination gas oil cracking and naphtha reforming furnaces, low-pressure tower systems for the viscosity breaking operation, and high pressure towers for the gas oil cracking and reforming operations, and integral stabilizing and clay treating equipment for producing finished specification gasoline.

No. 1 unit was shut down only four times during 1937, each run averaging 2,000 hours or over 83 days. The longest continuous run was for 3,097 hr. or more than four

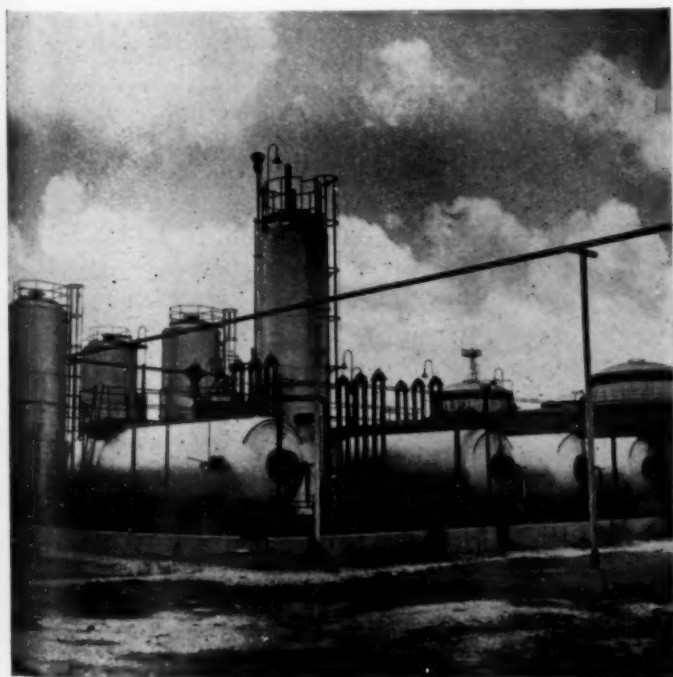
months. In other words, the equipment was "on stream" 91 per cent of the time. To say that it "ran itself" is not quite fair, but in order to simplify control and insure continuous and uniform operation, a great deal of automatic control equipment has been used. In fact the very large size of the unit made it economical to spend more money for instrumentation and control than ordinarily would be the case.

Result Is Automatic Operation

The result of all this has led to a refinery that is more completely automatic in its operation than any plant heretofore constructed, to units larger than had ever been constructed up to that time and to a simplified and efficient layout that has not been equalled in any refinery construction anywhere. At least, that is the considered opinion of this writer who, in the past 20 years, has witnessed many remarkable engineering advances in the petroleum industry. What is ahead in the 20 years to come is anyone's guess, but it now seems certain that the trend is toward manufacturing operations with the emphasis on chemical engineering processes for producing motor oils and fuels as well as many other useful products of chemical synthesis.

Continuous acid and alkali treaters for gasoline and kerosene are replacing batch agitators in most of those oil refineries constructed throughout the United States in recent years

Over \$50,000 has been spent for automatic control, indicating and recording instruments in one California refinery to complete a \$5,000,000 expansion program



Magnesium Metal and Compounds

Western United States is producing considerable quantities of magnesium refractories and salts, both from minerals and from sea water and bitterns. Will the coming magnesium industry find these suitable raw materials for metal production?

ALTHOUGH magnesium is one of the most widely distributed metals of the earth, it has not yet reached the state where it can be classed as a common metal in terms of use. It has never been found in the elemental form but usually as the chloride, hydrated oxide, sulphate, silicate or carbonate, either in simple or complex salts. According to Gann (Trans. A.I.Ch.E., 24, 207), it is surpassed in available quantity only by two of the metals normally used for construction, iron and aluminum.

Magnesium metal became more than a metallic curiosity shortly before 1914 when the Germans initiated commercial production, apparently using magnesium chloride from the Stassfurt deposits as the raw material. Some considerable demand for the metals developed in spite of the high price and when supplies were cut off by the war, the United States became a real factor in the industry. In 1915, the consumption of metal in the United States was 87,500 lb. at an average price of \$5 per pound. Since that time, the price dropped yearly until 1934, the price now being about 30 cents per pound. Greatest United States production was attained in 1934 with 4¼ million pounds.

The German firm, I. G. Farbenindustrie, is the world's largest producer of the metal. In the United States the Dow Chemical Co., which has been in production since about 1915, is at present the only producer although other firms formerly made the metal and at least one other large manufacturer still fabricates it. The German organization is associated with United States interests in a patent holding company.

Magnesium is somewhat similar to calcium and is an extremely reactive metal. It is quite easily oxidized as indicated by the fact that it will burn

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in steam. In the presence of chlorides and moisture, corrosive conditions are set up because of the formation of hydrochloric acid. These properties place limitations upon processes proposed for the manufacture of the metal. Even traces of impurities are apt to result in corrosion with a metal as reactive as magnesium. Therefore, processes for the commercial production of magnesium must produce a metal of extraordinary purity, either by direct process or by subsequent refining. Practically all of the processes in successful operation at the present time depend on the same final, essential step—an electric furnace fusion electrolysis of

magnesium chloride. To carry out this process a good source of magnesium chloride is a distinct advantage and it is quite necessary to have the magnesium chloride in a relatively pure state since most of the difficulties encountered are caused by the impurities. In the use of certain raw materials the steps of freeing the material from impurities and preparation of the chloride are often the most troublesome parts of the process.

Processes for reduction making use of the oxide have been proposed and several of them tried out commercially. These processes are of two general types, one modeled after the commercial process for production of aluminum, makes use of a magnesium fluoride bath into which is fed the oxide. Barium and sodium fluorides

Pachuca tanks and Dorr thickeners where bitterns react with calcium chloride in the California Chemical Co. plant at Newark, Calif.



are added to the bath to change its physical characteristics. Power consumption is high and fairly pure materials are required.

Another process uses the oxide in electric furnace reduction. Various modifications of this have been proposed, including replacing the magnesium with silicon or other element. Reduction by electric furnace does not require pure materials but the metal produced must be further refined.

Such a process has been placed in operation in Austria on a relatively small scale and a large plant was built in Korea several years ago. This process is quite complex and involves a number of steps which are difficult to carry out on a large scale. At last reports, the Korean plant was not yet accounted successful.

Difficulties with processes so far available, center around production of the metal with sufficient purity at a low cost. In the fused chloride process, a metal entirely free from chloride is difficult to obtain and as previously stated, the presence of chloride reduces the corrosion resistance of the metal. In the oxide reduction processes, the removal of metallic impurities is troublesome where the magnesium is purified by distillation, losses by vapor are frequently experienced, the distillation is expensive and the powdered material resulting must be carefully handled because of the danger of explosions.

The fused chloride electrolysis method has been developed to a high degree of perfection by the Dow Chemical Co., of Midland, Mich., where the salt is prepared from well brines by removal of bromine, impurities, and NaCl, followed by concentration and crystallization.

Several different magnesium raw materials, suitable for the manufacture of the metal, are available in the West, including magnesite in Washington and California, sea water bitterns from solar evaporation in California, brucite and magnesite in Nevada, and sea water from the Pacific Ocean. Dolomite is also available but is not here considered a very desirable source of magnesium. All these sources are being worked in the production of magnesium compounds.

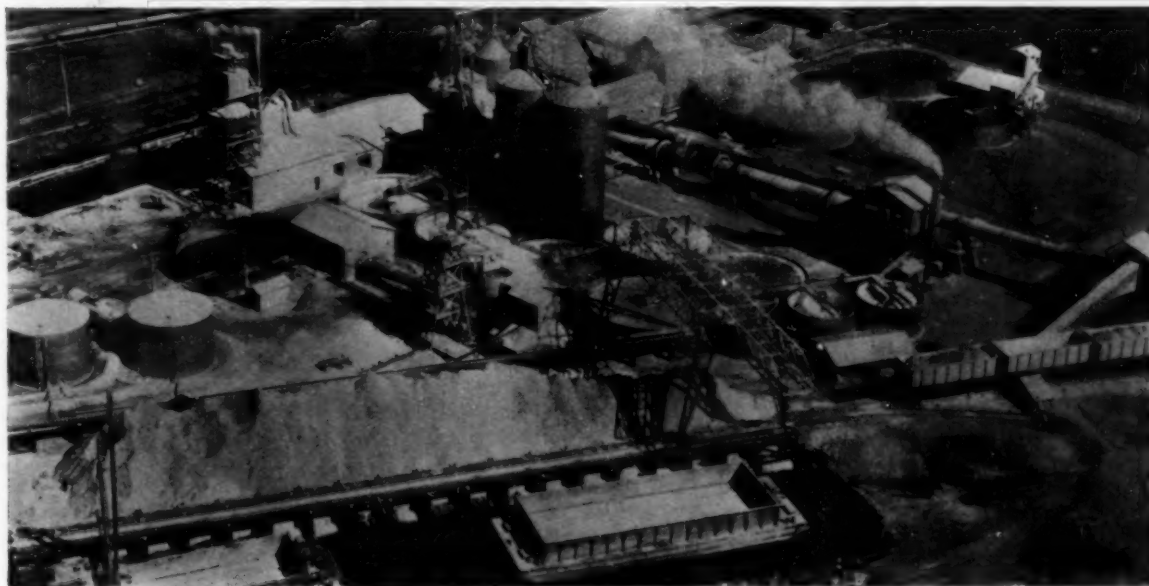
Magnesite deposits in Washington are almost exclusively controlled by the Northwest Magnesite Co. operating at Chewelah, Wash., while the deposits in central California are operated by the California Chemical Co. This Westvaco Chlorine Products Corp. subsidiary also controls most of the sea water bitterns produced in the state, the latter being used at the Newark, Calif., plant as a much more flexible raw material for magnesia in refractories than the mined material. This enterprise is favorably situated for the manufacture of magnesium metal, except from the standpoint of power. Transportation of finished product by either rail or boat is available.

The Nevada brucite and magnesite deposits are extensive, large reserves of both minerals being available. Transportation is the main problem. Power from Boulder Dam could be transmitted to these deposits without too excessive cost, especially if the transmission of power for this and other purposes could be combined. Brucite is an attractive raw material for magnesium manufacture by the electric furnace, especially if the ore is pure or nearly so.

Manufacture of magnesium compounds from sea water is being carried out by Marine Chemicals Co., at South San Francisco, and requires only lime in its raw material inventory. Such a process is simple, has a low operating cost, and can be established wherever there is sea water and good limestone at a low cost. A ton of burned lime, costing perhaps as little as \$6 per ton, produces approximately 1 ton of magnesium hydroxide, while sea water is not expensive to pump and the carbon dioxide from lime burning is used in making other magnesium compounds.

Both the sea water and bittern processes make pure compounds in which the magnesium content is entirely available. Considering these various factors, then, it would seem that unless a magnesium metal process can be developed which will handle magnesite direct or nearly worthless waste magnesite material, the magnesia or magnesium hydroxide from sea water or bitterns may

Plant of California Chemical Co. at Newark, Calif., with oyster shell barges in the foreground, magnesium hydroxide thickeners at left, kilns in center and gypsum thickeners at right



give magnesite some rather difficult competition from a raw material standpoint.

It is apparent after studying the processes now in use that none is really quite satisfactory for magnesium production from all standpoints, although the brine and bittern processes have the advantage of co-products in addition to magnesium to absorb part of the cost. A really good process for the production of the metal from the oxide seems to be what is needed, and while it is reported that the Bureau of Mines is to spend \$25,000 on a 5-ton experimental plant at Chewelah, Wash., it would appear that careful investigation of the sea water and bittern processes as sources of magnesia for this purpose should be made.

Other Pacific Coast industries offer good potential markets for magnesium hydroxide as an alkali reagent, including the pulp, petroleum and rubber industries, all of which are well represented in the Pacific states. There are now sufficient uses for magnesium compounds of the hydroxide, oxide and basic carbonate types to support a growing industry in the West.

Bittern Plant

Several years ago, *Chem. & Met.* described the bittern and sea water processes (Nov., 1931; and Mar., 1936). These processes have both been improved and we are again

briefly discussing them to show the changes and emphasize the importance of both processes in the magnesium industry.

A new magnesia plant was built in 1937 by the California Chemical Co. at Newark, Calif. This plant represents a beautifully arranged collection of chemical engineering equipment which has been described in complete detail by W. E. Trauffer in *Pit and Quarry*, May, 1938.

Since the evaporation of salt water in the San Francisco region is a seasonal operation, the bittern is run from the salt ponds into large storage vats from which it is available as needed in operation. Storage capacity is approximately 100,000,000 gal. The bittern is used to produce bromine, calcium sulphate (gypsum) and magnesium hydroxide, although the bromine recovery stage of the process may be omitted or operated at will, according to the demands of the market. When practiced, the bittern is drawn from storage, neutralized with sulphuric acid and used in bromine manufacture as previously described (*Chem. & Met.*, Nov., 1931, p. 638). The spent bittern goes to magnesia recovery.

As required, the bittern (either raw or spent) is introduced together with calcium chloride solution from another part of the process into one of three batch Pachuca tanks where calcium sulphate and magnesium chloride are formed. As shown in the



New construction at the plant of the South San Francisco. Note the inclosed

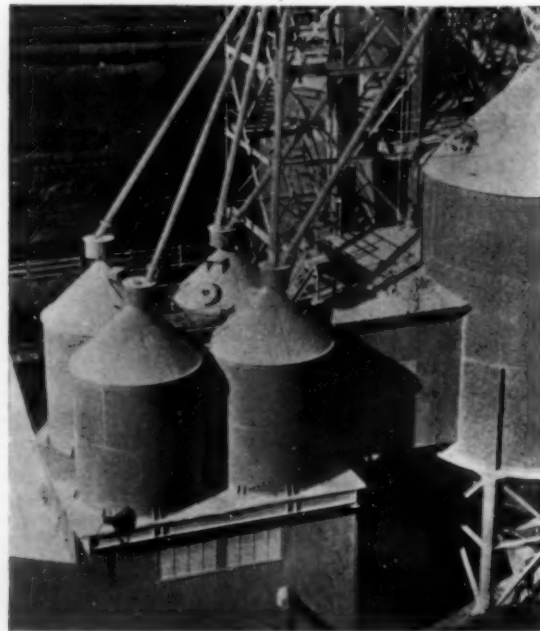
accompanying flow sheet the calcium sulphate and mother liquor pass to the first of two Dorr thickeners in series, each of which is 55 ft. in diameter and 12 ft. high. The calcium sulphate slurry is filtered on a cast-iron Oliver filter, washed and then dried with recirculated dry material in a Raymond kiln mill. The gypsum produced (about 90 tons daily) is stored; and much of it is shipped to a nearby cement plant.

Now free from sulphate, the magnesium chloride mother liquor is treated with lime. Lime from the lime plant enters a larger primary

Lime kiln, magnesia kiln and hydroxide thickeners in the California Chemical plant



100-ton shipping bins for magnesia, and one of the six 500-ton magnesia storage bins





Marine Chemicals Co., Ltd.,
Dorr thickener at the right

reactor where it is mixed with a small amount of the magnesium chloride liquor. This mixture passes into the smaller secondary reactor where it meets the main body of magnesium chloride liquor, then flowing to a rotating drum, 36 ft. long, which serves to prolong the time available for the reaction of any slowly reacting particles of lime, provides a retention tank for the reacting material and tends to make particle size more even.

The slurry discharges into a Dorr thickener. The overflow, mainly calcium chloride solution, is used in the first part of the process while the thickened $Mg(OH)_2$ slurry is washed countercurrently with water in a series of four 55x12-ft. Dorr thickeners. Pretreated water is used to minimize impurities and losses. The final slurry is pumped to a set of three tanks, each 30 ft. in diameter and provided with Dorr agitators, where it is settled and decanted, then mixed, with the assistance of an auxiliary mixer, with other ingredients desired in the refractories being made. After thorough agitation the slurry is filtered on an Oliver filter and the cake calcined in a Traylor kiln, 190 ft. long and 11 ft. in diameter. The magnesite passes to a 60x6-ft. rotary cooler and finally is conveyed to storage silos. If desired, crushing and sizing precede the final storage from which the material is drawn as needed for shipment. The capacity of the plant is approximately

60 tons per day, including all magnesium products: light burned magnesite, dead burned magnesite, periclase, several grades of MgO .

Lime used in the process is made from oyster shells dredged from practically inexhaustible deposits in San Francisco Bay. During the barge trip to the plant the shells are thoroughly washed with bay water in a rotating screen, so as to remove most of the silica and other impurities. From the plant storage pile the shells feed into a 7½ ft. lime kiln, 315 ft. long. The kiln gases pass through a dust chamber and the dust is mixed into the feed to the kiln, being held by the damp shells. Meanwhile, the burned lime passes through a rotary cooler, 50 ft. long, the heated air being used in the kiln combustion. The plant capacity is 100 tons of lime per day of which about 25 tons is available for marketing as hydrate.

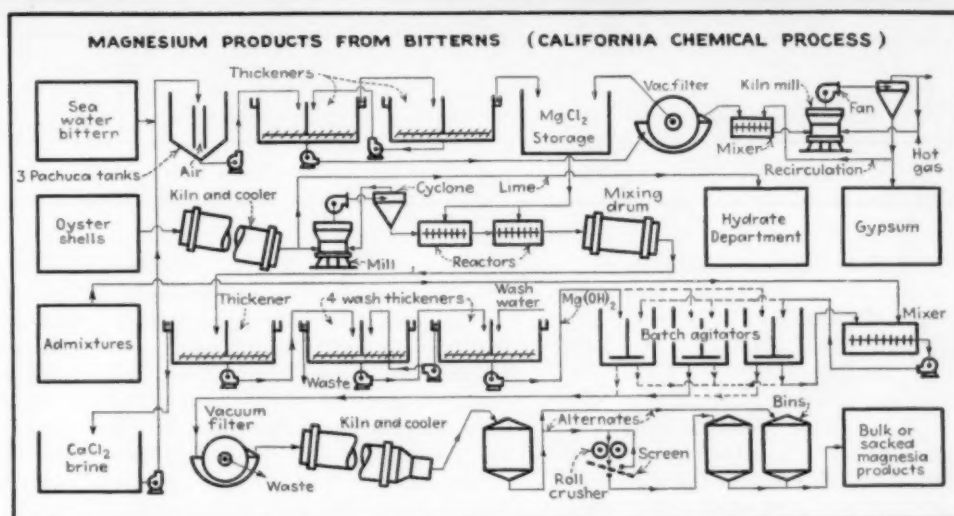
The whole plant is well engineered

and constructed. Automatically controlled equipment predominates, insuring uniform quality products at low operating costs. The Dorr installation is one of the finest this writer has seen. Slurries are handled by the recently developed Oliver-Sabin automatic, vacuum-operated, constant-volume pumps.

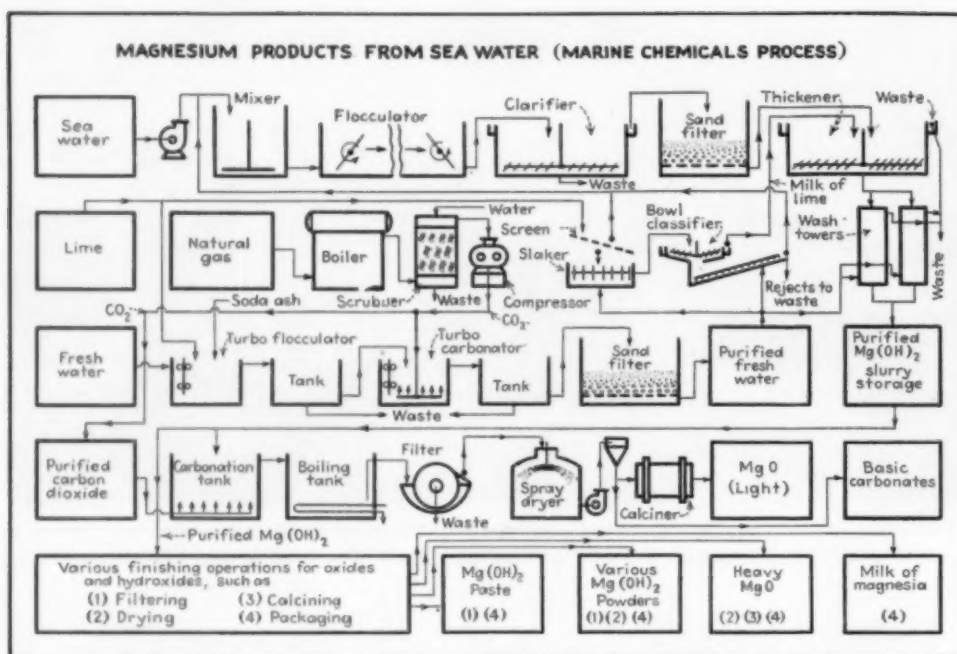
Sea Water Plant

Across San Francisco Bay at South San Francisco is the plant of the Marine Chemicals Co., Ltd. Since the earlier description (*Chem. & Met.*, Mar., 1936) the process has been improved, new products developed and new equipment installed. (See flow sheet on p. 482.)

Sea water is first pumped to a vertical mixer mounted on one end of a large Dorr flocculator. In the mixer, a small amount of milk of lime, specially prepared in a Dorr bowl classifier, is mixed with the sea water.



Flow sheet showing principal steps in California Chemical Co.'s operations



The purpose of this treatment is to remove the bicarbonate ions and clarify the incoming "raw material". The flocculator discharges into a 90 ft. Dorrr clarifier, 14 ft. high. This as well as the flocculator is new.

After passing through this clarifier, the pretreated water passes through a sand filter from which it emerges sparkling clear. It is then pumped to the top of a larger Dorrr thickener, entering a specially designed center chamber after having been mixed with a lime slurry. The thickener is something rather new in this type of installation. It is a concrete tank 100 ft. in diameter by 20 ft. high, capped with a concrete roof supported on galvanized iron trusses. The bottom of the tank is also of concrete. The concrete was poured in three operations: first the floor, then the tank, finally the roof. No expansion joints were used. To assist in settling the slurry the arms are supplied with numerous vertical members in addition to the plows.

The lime circuit has also been revised. Lime is screened and slaked with water from the new water treating system. The slaked lime passed into a Dorrr bowl classifier and the milk of lime produced is used in the pretreatment and main circuit.

In the new fresh water circuit, fresh water is treated with lime and soda ash in a Turbo flocculator, followed by a settling tank, the overflow of which enters a Turbo car-

bonator supplied with CO_2 gas from the compressors. This removes any excess lime. The water then passes through a second settling tank, through a sand filter and to storage.

The magnesium hydroxide slurry from the thickener passes into washing towers where it is countercurrently washed with treated water. The washed magnesium hydroxide goes to storage from which it is drawn to supply the remainder of the process. If magnesium hydroxide powder is being made, the slurry is spray dried. If the hydroxide paste is

being made, the slurry is further concentrated and packed into special drums for shipment.

In the manufacture of basic carbonates, the slurry passes to a carbonating tank where it is carbonated using boiler flue gases which have first been scrubbed with water and compressed by a Roots blower. After carbonation, the slurry is expanded by boiling, filtered on an Oliver filter and passed to the spray dryer. This is the same Peebles spray dryer that was previously described.

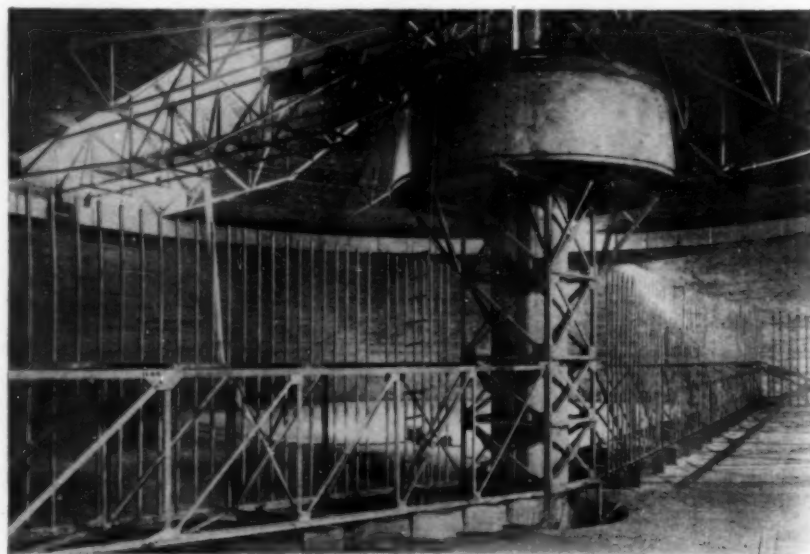
Magnesium oxides of several grades are made by calcining the appropriate product.

With the newly installed equipment the capacity of the basic plant has been raised to approximately 40 tons daily, stated in terms

of basic carbonate. Products made include fine grade materials for pharmaceutical and chemical purposes, a number of different grades of basic carbonates, hydroxides and oxides, milk of magnesia and hydroxide pastes. Refractories are not made at this plant.

Grateful acknowledgment is made to M. Y. Seaton and W. N. Williams, of the California Chemical Co., and to R. E. Clarke, of the Marine Chemicals Co., Ltd., for permission to visit their plants and prepare data for this study.

Inside new concrete Dorrr thickener at Marine Chemicals Co. plant



Trail Solves Its Sulphur Problem

Mining some 2,000 tons of sulphur per day as sulphides of zinc, lead and iron, in past years the Trail Smelter had a difficult fume disposal problem. First, sulphuric acid was produced, and then a fertilizer industry was built to use the acid. Now the final link has been forged, in an elemental sulphur recovery plant employing a process uniquely applicable to Trail and without parallel elsewhere in the world.

NECESSITY HAS MOTHERED many inventions, but none of more interest and importance to chemical engineers than some of the significant developments that have been made at Trail, B. C., since 1930. During the past eight years Consolidated Mining and Smelting Co. of Canada, Ltd., has spent more than \$15,000,000 in building a chemical and fertilizer industry that is without parallel anywhere else in the world. The pioneering production in Western Canada of sulphuric acid, synthetic ammonia, and concentrated phosphoric acid, which it was this writer's privilege to describe in 1931 (see *Chem. & Met.*, Nov., 1931, pp. 626 to 631; also articles in Dec., 1932, and Feb., 1933, by William C. Weber), has now made an even more

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striking advance in the recovery of elemental sulphur. A unique process, ideally suited to the local conditions and raw materials available in Trail, has been developed as a result of the company's own research which began in 1932. More than 500 tons of elemental sulphur was recovered in a pilot plant in 1935. The first commercial unit went into production in the summer of 1936 and last year had a total production of 13,533 tons. The present plant is recovering almost 100 tons a day and when the current expansion program is completed later in 1938, it is expected that the daily capacity will be prac-

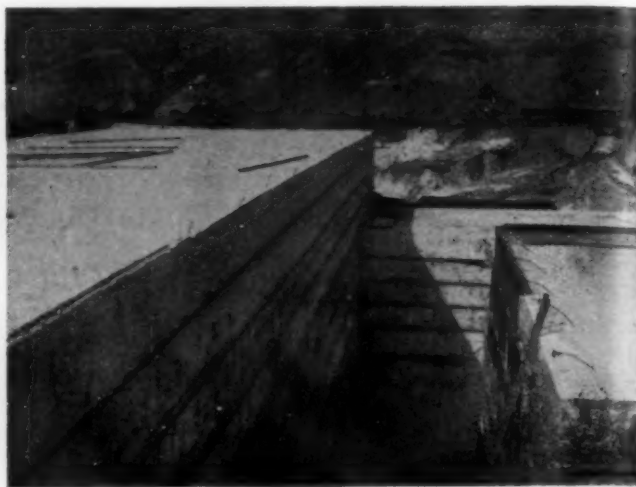
tically doubled. Summarized below is Trail's chemical output in short tons:

	Sulphuric Acid, 100 Sulphur	Ammonium Fer- Sulphate	Phosphate and Other Fertilizers
1929	3,065	.....	.....
1930	8,501	.....	.....
1931	36,170	6,485	18,571
1932	73,039	46,721	14,420
1933	64,219	65,810	3,058
1934	95,434	55,780	26,717
1935	543	120,245	42,949
1936	3,464	126,578	71,630
1937	13,533	132,194	57,832

Before attempting to outline the interesting steps in this newest process, it is worthwhile to recall the broad outline of the problem as a whole. The existence of the entire chemical and fertilizer department at Trail depends very largely on the fact that the lead and zinc ores from the famous Sullivan Mine are sul-

General view of the Tadanac plant of Consolidated Mining and Smelting Co. of Canada, Ltd., Trail, B. C.





Above—Looking down on a part of the 20,000 tons of solid sulphur in storage in the Trail stock pile

phides. The first step in the metallurgical process is to concentrate the lead and zinc values by selective flotation, in which operation some 1,500 tons of sulphur and 2,200 tons of iron are separated as iron sulphide and eliminated in the mill tailings. This leaves approximately 400 tons per day of sulphur in the concentrates which when roasted yield gases ranging from 0.8 to 6.8 per cent SO_2 .

Logically the first means of utilizing this waste gas was to produce sulphuric acid and about ten years ago the original 35-ton contact unit was installed. This was followed with three 120-ton units of modern design employing vanadium oxide catalysts. Now, still another unit, this of the Monsanto type, is under construction and when completed the total capacity will be in the neighborhood of 600 tons per day of 100 per cent sulphuric acid.

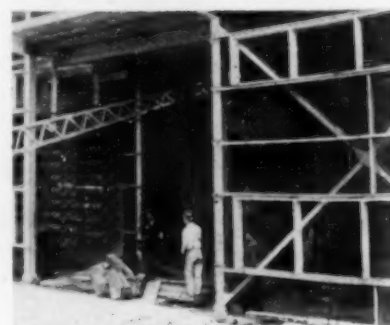
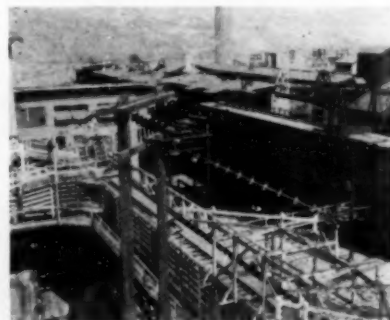
In spite of this tremendous output, which comes close to being the largest on the North American Continent, there would still be approximately 10 per cent of the sulphur unaccounted for were it not for this latest product of Trail's chemical engineering research and ingenuity. The sulphur recovery process, in essence, consists merely in the absorption of the SO_2 from the roaster gases in ammonium sulphite solution from which it is eliminated as 100 per cent SO_2 by treatment with concentrated sulphuric acid. The pure SO_2 is then reduced by incandescent coke to elemental sulphur which is readily refined to yield the 99.99 per cent brimstone of commerce. To carry out such a process on a large scale is obviously not quite so simple. Yet considering that it had never before

been attempted commercially, the plant has proved most successful.

The roaster gases are first cleaned of dust in Cottrell electrostatic precipitators, then washed and cooled with water and passed to the SO_2 absorption plant. Motor-driven fans of 100 hp. are required to circulate the gases. The absorption towers are wood, 17 ft. square and about 30 ft. high, covered on the outside with lead—which for obvious reasons is Trail's most popular material of construction. The towers are filled with wood-plank packing. The gases go through four absorbing towers, flowing either counter-current or concurrent with the circulating solution of ammonium sulphite and ammonium bisulphite. The latter is formed when the SO_2 is absorbed in the sulphite and since the absorption ceases when all of the ammonia is converted into the bisulphite form, extreme care must be exercised in the control of concentrations, temperatures and absorption velocities. As the ammonium bisulphite builds up to a strength of about 5 to 6 lb. of SO_2 per gal., part of this solution is drawn off and aqua ammonia added.

Temperature is controlled by passing the circulating solution through water-cooled aluminum tubes in specially designed heat exchangers, immediately after addition of the ammonia. This removes the heat of reaction and brings the temperature down to about 40 deg. C., or less, which is suitable for absorption. The ammonium bisulphite solution must be filtered through three Shriver iron plate-and-frame filter presses in order to remove any calcined material or other solids carried over from the roasters.

Below—Smelter fume duct to the conversion plant; the conversion plant undergoing enlargement; and new equipment for sulphur production being erected in the plant



The next step is to mix the bisulphite solution with the concentrated sulphuric acid which has previously been used to dry the final SO_2 . This is accomplished in a cylindrical acidifying tank, from which the solution (which is now ammonium sulphate containing a small amount of occluded SO_2) is pumped to the eliminators. These last are lead towers 8 ft. in diameter and 40 ft. high, lined and packed with acidproof brick. Steam entering at the bottom drives off the SO_2 which passes first through a cooling tower, is then dried with concentrated sulphuric acid and, after finally being filtered through coke, is ready for the reduction plant.

The process is so controlled that the ammonium sulphate solution in the eliminators is almost saturated. It is drawn off, passed through a heat exchanger and then pumped through almost a mile of 6-in. spiral rubber-lined steel pipe to the fertilizer plant on Warfield Flat, about 400 ft. above the level of the sulphur plant.

At Warfield the ammonium sulphate solution is pumped into four

Oslo crystallizers where the water is evaporated off, yielding unusually large and beautiful crystals of ammonium sulphate ready to be marketed, often at a premium over other byproduct sulphate.

Some of the 100 per cent SO_2 from the eliminators is pumped back to the sulphuric acid plants to enrich the intake and thus increase the maximum rate of economic operation. This is then another example of Trail's ingenuity in the efficient utilization of all of its resources.

Most of the SO_2 , however, is brought over to the sulphur reduction plant in a 26-in. pipe. Here it is picked up by Elliott blowers and then forced, with a small amount of pure oxygen from the liquid air plant (more interdependence!) into the bottom of a coke-fired reduction furnace. These furnaces are in reality gas producers, especially designed by the Power Gas Corp., Ltd., of Stockton-on-Tees, England. The coke is charged in at the top and the ash taken out on a rotary grate and through a water seal at the bottom.

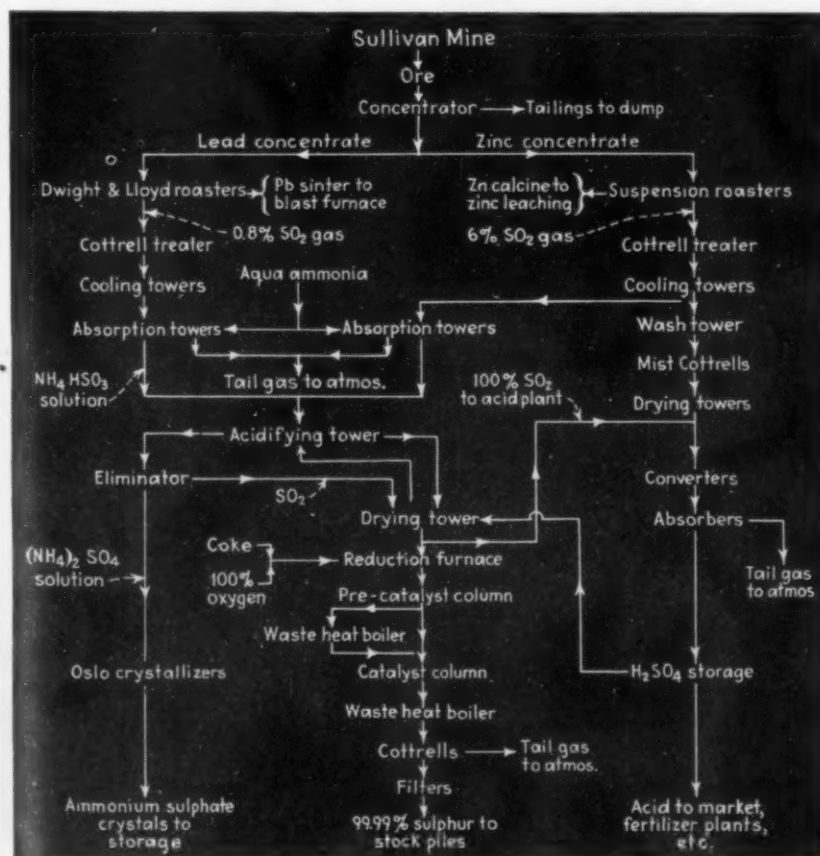
The reason that the supplementary

oxygen must be added to the SO_2 is that the reaction, although slightly exothermic, cannot support itself and the oxygen must make up the heat lost by radiation. Furthermore, the reducing reaction does not go to completion in the furnace, but various side products are formed so that the exit gases contain, in addition to elemental sulphur and carbon dioxide, considerable quantities of carbon monoxide and carbon oxy-sulphide (COS) and occasionally even small percentages of carbon bisulphide. The carbon oxy-sulphide must be converted to carbon dioxide and sulphur by catalytic reaction with SO_2 . Accordingly, the necessary amount of SO_2 is added to the exit gases from the reduction furnace, which then flow through a pre-catalyst column where the greater part of the COS is converted. Since the reaction raises the temperature above the optimum for completion of the catalysis, the gases next pass through a waste heat boiler for partial cooling, and then enter the catalyst column where the catalytic material is used as the tower packing. The reaction completed, the gases enter a second waste heat boiler where they are cooled so that most of the sulphur is condensed to a liquid, that remaining as a mist being precipitated in Cottrell treaters.

The liquid sulphur at this stage is exceptionally pure, but slightly off-color, due to very small quantities of occluded carbon. This was formerly removed in a high tension electrostatic precipitator, but recently it has been found more satisfactory to filter the molten sulphur in a gravity filter employing fabric stocking filters. The product from these filters is of high purity (over 99.99 per cent) and solidifies to a brilliant yellow mass. However, while still in liquid form, it is pumped from steam-heated storage tanks, either to a flaking mechanism or to the sulphur storage pile to solidify.

At the time of this writer's visit in July, approximately 20,000 tons of sulphur was in storage. Some Trail brimstone has been shipped to the pulp and paper industry and some to the farmers for crop dusting. The primary importance of this sulphur, however, lies in the fact that it is something more than a marketable byproduct. It is Trail's successful solution for one of its major problems and one peculiarly adapted to its native resources.

Flow diagram showing the principal steps used by Trail in its three methods of fixing sulphur



What About Western Phosphates?

Are recovery costs as low as have been optimistically reported? Can we look for new T.V.A.'s springing up at every potential damsite? An impartial observer assays these resources and reports on the present status of their development.

IN HIS SPECIAL MESSAGE to Congress on May 20, 1938, President Roosevelt brought to the nation's attention some of the problems involved in the utilization and conservation of our phosphate resources. He called particular attention to the large deposits of Idaho, Montana, Utah and Wyoming, which represent approximately 90 per cent of our total reserves as compared with 7.4 per cent in Florida and 1.4 per cent in Tennessee. As a direct result of this message, the Congress authorized an extended investigation by a joint committee of the Senate and House. Hearings are in progress and a report will be made to the next Congress. As an indirect result of presidential sponsorship for this regional activity, promotional agencies among various states and local groups were immediately galvanized into action. Dozens of schemes have been proposed by ambitious communities that envisioned T.V.A. phosphate plants at nearly every potential damsite.

Obviously this article is not an appropriate medium for discussion of these various schemes nor for any argumentative presentation of the claims made for rival communities. Nor can we report any exhaustive first-hand survey of these Western phosphate resources. However, certain facts regarding the general character of these resources and of the present status of their exploitation, as viewed by an impartial observer, may not be out of place in this Western issue of *Chem. & Met.*

Over a period of years there have been many attempts to develop phosphate mines in these four Western

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states, but, with a few notable exceptions, all of them were unsuccessful. Today one can find abandoned tunnels, shafts and open cuts scattered throughout the area. In Idaho the only important mine in operation is that of the Anaconda Copper Mining Co. at Conda, near Soda Springs. There are no active mines, to our knowledge, in either Utah or Wyoming. The Anderson mine, near Garrison, Mont., is now supplying the phosphate rock requirements of the Consolidated Mining & Smelting Co. of Canada, as well as certain U. S. demands. The total production from Idaho and Montana during the past five years is given in Minerals Yearbook, 1937, as follows:

Year	Idaho Long Tons	Montana Long Tons	Total Long Tons
1932	23,172	20,090	43,262
1933	19,751	492	20,242
1934	37,151	2,086	39,237
1935	41,796	27,497	69,293
1936	47,113	36,022	83,135
1937	82,436	50,834	134,270

All western phosphate is mined at present by underground methods comparable to coal mining, i.e., using tunnels, shafts, and stopes. In only a few places open quarrying might be employed but it is doubtful if sufficient rock could be obtained for large-scale operations without resorting to underground mining methods. Estimates of mining costs as low as 25 cents per ton have been noted in some of the more optimistic reports, but most impartial observers feel that \$2.50 to \$3 per ton would appear more probable.

The main ore tunnel of the mine at Conda, Idaho, is about 8,000 ft. long. The Anaconda Company is mining a 7-ft. seam running 32 to 33 per cent P_2O_5 from stopes above the tunnel. This ore is dropped down a shaft about 500 ft. to the main ore tunnel where it falls into a concrete bin that holds about 400 tons. At this point the ore cars are loaded and hauled to the mill on the other side of the hill. Here the ore is crushed to about $\frac{3}{4}$ in. and, when necessary, it is dried in a Ruggles Coles dryer in order to prevent freezing in transit to the reduction plant at Anaconda, Mont. In addition to the requirements of this plant, which are approximately 400 tons per day, the Conda mill ships about 10,000 tons of ground phosphate per year to supply the superphosphate plant of the Stauffer Chemical Co. in California.

The Anderson mine, northeast of Garrison and about 24 miles from Deer Lodge, Mont., employs about 75 men to produce approximately 450 tons per day. The vein now being mined is 3 to 4 ft. thick and of good grade (32 per cent P_2O_5). The principal shipments are to the Consolidated Mining & Smelting Co. of Trail, B. C., although the company also operates a grinding plant and sells some raw ground rock in the U. S. According to the annual report of its principal customer, the Anderson mine in 1936 produced 36,022 long tons of phosphate rock.¹

¹ J. T. Pardee in Bulletin 847 of the U. S. Geological Survey, published in 1936, described in detail other Montana deposits near Maxville, Philipsburg and Avon, and also discussed economic and technical problems faced by the productive phosphate rock areas of that state.

Chemical processing of these western phosphates centers in the plant of the Anaconda Copper Mining Co. at Anaconda, Mont., and that of the Consolidated Mining & Smelting Co. of Canada, Ltd., at Trail, B. C. Both employ the wet process, which utilizes sulphuric acid. Both produce so-called "triple" superphosphates and, in addition, the plant at Trail, because of its synthetic ammonia operations, also manufactures ammonium phosphate and mixtures of ammonium phosphate and ammonium sulphate.

Anaconda is one of the pioneer producers of superphosphates of high analysis, having begun its operations in 1920. By efficient processing it is able to produce from each long ton of phosphate rock about 1,400 lb. of "treble" superphosphate which is sold under guarantee as containing not less than 45 per cent available P_2O_5 . According to its annual report for 1937, the Anaconda Copper Mining Co. produced last year 45,861 tons of treble superphosphate and phosphoric acid.

At Anaconda, the rock phosphate which is received from the mine in coarsely ground condition, is first roasted in Wedge furnaces to burn off the organic matter. It is then ground in a Hardinge mill, screened through a 35-mesh screen and the oversize returned to the mill.

The 60 deg. Be. sulphuric acid from the company's large chamber plant (see article by late E. L. Larison, *Chem. & Met.*, April 5, 1922, p. 642 ff. and May 3, 1922, p. 830 ff.) is diluted with weak acid from the calcium sulphate washing filters to give a strength of about 26 deg. Be. The ground rock and acid are fed continuously to three large agitators and the resulting slurry passed to the first of a series of 50-ft. Dorr thickeners. The underflow from the final thickener is dewatered and washed on Oliver filters before discarding.

The phosphoric acid from the Dorr plant is now concentrated to 55 deg. Be. in Swenson evaporators although experimental work is being done on a radically different type. During the concentration and subsequent cooling of the phosphoric acid, sodium silicofluoride mixed with calcium sulphate separates out. The phosphoric acid is deep green in color due primarily to the presence of vanadium and chromium salts in solution.

Rock phosphate for the final mixing of rock dust and acid is roasted in Wedge furnaces and ground to pass a 45-mesh screen. From the mixer, the slurry is poured onto a long slow-moving dished belt. By the time it reaches the end of the belt, it is set up sufficiently to be broken into chunks in which form it is stored for curing. It is then dried, disintegrated in a ring-roll mill, screened through 6-mesh and bagged into paper bags holding 100 lb. each.

Operations at Trail

The phosphoric acid and ammonium phosphate plants of the Consolidated Mining & Smelting Co. of Canada, Ltd., have been so recently described in *Chem. & Met.* that the details of their operations need not be repeated here. (See articles by William C. Weber, Dec. 1932, pp. 659-662 and Feb. 1933, pp. 72-75). In general the plant at Trail consists of three units having a total capacity for processing 450 tons of phosphate rock per day. The acid produced contains 32 to 33 per cent P_2O_5 and is used for the production of three different types of phosphate fertilizers, viz.: (1) Ammonium phosphate containing 11 per cent nitrogen and 48 per cent phosphoric acid. This is produced by the partial neutralization of phosphoric acid with synthetic ammonia gas. (2) Ammonium phosphate-sulphate containing 16 per cent ni-

trogen and 20 per cent phosphoric acid. This is produced by partial neutralization of a phosphoric acid-ammonium sulphate solution with synthetic ammonia, and (3) triple superphosphate with 43 per cent available phosphoric acid, as at Anaconda, by the interaction of phosphoric acid and phosphate rock.

Depending on the proportions of these three materials being manufactured, the three units of the phosphate fertilizer plant at Trail have a total capacity of 300 to 450 tons of finished product per day. Much of this material is exported to British provinces in the Orient and elsewhere, but a considerable quantity finds its way back to American farmers and citrus growers in the Western states. Our imports from Canada in 1937 were 21,700 tons of ammonium phosphate valued at \$745,000 and some 2,000 tons of triple superphosphate valued \$64,000. California is one of the largest consumers of the ammonium phosphate. The beet sugar industry of Colorado and Utah has been a most important customer for Anaconda's triple superphosphate although the product is widely used for other crops in the Mountain States. Test plots of alfalfa made this year at the Aberdeen Agricultural Experiment Station in Idaho are said to have shown better results with 45 per cent triple superphosphate than with equivalent amounts of calcium metaphosphate containing in excess of 60 per cent P_2O_5 .

Any further development of these Western phosphate resources must take into consideration the existing competitive situation and the adequacy with which present market requirements are being met by private enterprises. Serious economic as well as technical problems are certain to be involved. It would indeed be unfortunate if they are to be further complicated by political considerations.

Phosphates and fertilizer plant of Consolidated Mining & Smelting Co. of Canada, Ltd., at Trail, British Columbia



A Potash Industry—At Last!

In 1930 Chem. & Met. editorially asked the question, "Are we nearing potash independence?" pointing to the flourishing industry at Trona and suggesting that successful commercial exploitation might next be expected in the New Mexico sylvinitic area. This development has now come to pass and our question can be answered in the affirmative. America has a potash industry capable of covering all requirements if need should arise.

AMERICA NOW HAS a potash industry of which we may well be proud. It is a development of comparatively recent years, made in the face of devastating competition from abroad and without the benefit of tariff protection. That it was made in spite of serious natural handicaps in climate and distance from consuming markets is a tribute to patience and perseverance as well as chemical engineering achievement. Today three large American plants in New Mexico and California are supplying at least half of this country's potash requirements and, in case of an emergency, might readily be expanded to meet all demands that might be made.

Many of us remember when such a production of potash in this country seemed an almost forlorn hope. We saw the time when in 1909 a cancellation of the American contracts with the German syndicate involved a loss to American farmers of \$28,000,000 over a seven-year period. We saw the World War skyrocket prices from \$40 to more than \$400 per ton—followed by the frenzied effort of chemical industry to recover this vital element from wood ashes, distillery slops, kelp, cement mill dust, Utah alunite, Wyoming leucite, New Jersey greensands, California and Nebraska brines and a half dozen other sources. With the return of German and French imports, most of these enterprises failed. A comparatively small amount of potash is still recovered from the distillery wastes of the U. S. Industrial Alcohol Co. at Baltimore and from the cement kiln

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furnaces of the North American Cement Corp., at Hagerstown, Md., but by far the most important survivor is the interesting and efficient plant of the American Potash and Chemical Corp., at Trona on Searles Lake in California. Started in 1916, it is still the largest single producer of high-analysis potash on the American Continent.

Writing of the most recent chapter in the history of the industry com-

menced in New Mexico early in 1931, when the United States Potash Co. made the first commercial shipment of crude natural potassium chloride taken from an American mine that compared favorably with those of Germany and France. In 1932 this company constructed its modern refinery (see *Chem. & Met.*, April, 1933, pp. 172-6) and thus was soon equipped to meet demands for the purer and more concentrated product. A second producer, the Potash Co. of America, entered the Carlsbad field at about the same time, completing its first shaft in 1933 and building a large refinery which employs a unique proc-

Dumping cars of sylvinitic over the grizzly in the United States Potash Co.'s mine near Carlsbad, N. M.





General views of the United States Potash Co. properties with the mine buildings above, refinery below

ess for recovering the potassium chloride. These two plants in New Mexico, both of about the same capacity, are each producing approximately 400 tons per day of pure KCl, compared with an estimated daily production at Searles Lake of about 500 tons of KCl. Trona, in addition, also produces 285 tons of borax, 150 tons of soda ash and 200 tons of sodium sulphates per day.

On a couple of hot days this summer, when the temperature was well over 100 deg., this writer had the privilege of visiting all three of these interesting plants. It was his first trip to Carlsbad and he did not miss the opportunity to inspect the wonderful Carlsbad Cavern which has been set apart as a national park. It was indeed an inspiring and gratifying experience that one can heartily recommend to any fellow traveler.

On the following day the writer stood at the bottom of the United States Potash Co.'s shaft, a full 1,000 ft. below the surface. Here was a crystal cavern with walls and ceilings of the mixture generally known as sylvinites—containing approximately 40 per cent of KCl (sylvite) mixed with about 60 per cent of common salt (halite). The bed being mined is a layer 10 ft. thick, of remarkably uniform appearance and analysis and practically horizontal which permits it to be mined like coal, using the room-and-pillar system. No

timbers are necessary. The tunnels or drifts radiate away from the shaft where a circular area of about 1,000 ft. in diameter has been left for its protection. The rooms, about 40 ft. wide, are cut off from the drift in panels of eight or ten. Electric undercutters, similar to those employed in coal mining, are used and then the working face is drilled with electric auger drills to a depth of about 7 ft. and shot down with an explosive such as "Gelamite." The broken ore is loaded by mechanical muckers into cars which hold about 3 tons each. Electric trains of 12 cars operated from an overhead cable carry the ore to the shaft where the cars are dumped automatically, the ore falling through a grizzly to be loaded into the skip and hoisted to the surface. The 1,000 ft. trip requires just one minute. On the surface the ore is crushed, loaded into special dump-type cars and shipped by private railroad to the company's refinery which is about 15 miles away and about a mile from the Pecos River.

Here it is refined by a fractional crystallization process that depends primarily upon the fact that sodium chloride is less soluble in a hot than in a cold saturated solution of potassium chloride. Thus, when a saturated solution of the mixed salts in water is cooled from its boiling point, KCl crystallizes out contaminated with only what NaCl is entrained.

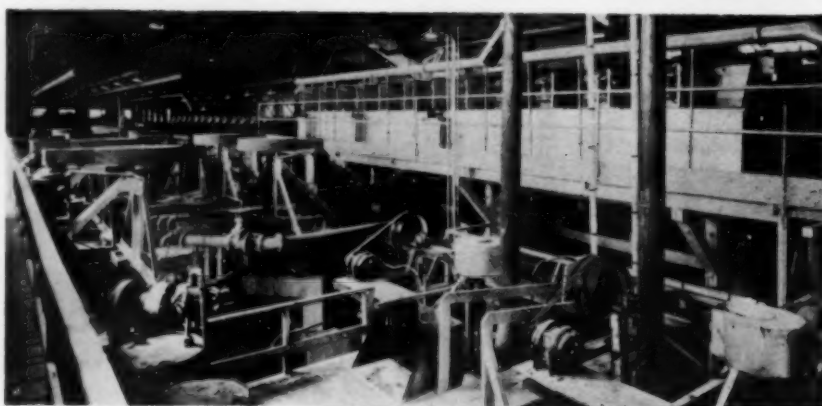
As the refining process is carried out in practice, it consists essentially in heating such a cold saturated solution to about 110 deg. C. which is its boiling point at the plant elevation of 3,500 ft. This solution is then pumped into a bed of ground sylvinites and dissolves out a considerable part of the KCl with only a little of the NaCl. When cooled in vacuum evaporators, a part of the KCl immediately crystallizes. The excess mother liquor is decanted through launders and the potash crystals are filtered and dried on special top-feed Oliver filters. The drying on the filter is accomplished by the forced circulation of hot gases from special natural gas furnaces. It only remains to crush and screen the product and it is ready for shipment or for storage in the warehouses. Potassium chloride so obtained will contain in excess of 60 per cent of K_2O . Other grades of material such as "manure salts" containing only 25 or 30 per cent of K_2O are still being marketed although in small amounts since there is a definite trend toward higher analysis material—of course with resulting economy in freight rates.

The writer did not have an opportunity to visit the neighboring mine of the Potash Co. of America but its operations have been described recently in some detail by its manager, R. M. Magraw, at the Dallas meeting of the American Chemical Society.



Air view of the mine buildings and refinery of Potash Co. of America, near Carlsbad, N. M., with the processing and storage area at the rear, the head frame in the center distance and administration and housing quarters in the foreground

(See *Ind. Eng. Chem.*, Aug., 1938, for this and other interesting articles from the same symposium on potash). The refinery employs an unusual process which for patent reasons cannot be discussed in equal detail, although it may be stated that the separation of KCl from NaCl is accomplished chiefly by a metallurgical concentration method, rather than by fractional crystallization, using a soap flotation process developed by the company engineers in cooperation with Prof. A. J. Weinig at the experiment station of the Colorado School of Mines. The sylvinite ore, having been coarsely crushed underground, is hoisted in skips up the 1,000-ft. shaft and discharged to a bin feeding a Symons cone intermediate crusher which in turn discharges to a series of fine crushers close-circuited with the screens. The ore at about 40 mesh is then wet ground to about 100 mesh in four ball mills close-circuited with Akins classifiers, using a saturated grinding solution. The remainder of the process is substantially as follows, although exact details have never been given out: The mill product, having been ground sufficiently to release the KCl and NaCl, is treated in two series of flotation cells to float off a salt concentrate and depress a KCl concentrate. The NaCl crystals are washed and separated from the solution by means of a Dorr thickener and a Moore filter and sent to waste while the KCl concentrate, together



Thickener, storage and pelleting buildings at the Potash Co. refinery
Agitator and flotation department in the Potash Co. refinery

with KCl crystals recovered from various circulating solutions, is separated by a classifier into fine and coarse fractions. Recovery of the fines is accomplished by a thickener and centrifugals, the discharge from which is pelleted to lima bean size. The pellets are dried in a Ruggles-Cole

dryer and crushed coarsely to the uniform size desired by fertilizer manufacturers. The coarse product from the classifier, however, requires only filtration and drying to make it ready for transportation to the storage building. Various blends and concentrations of muriate are made for special

requirements, but the most popular product is probably that containing in excess of 50 per cent of K_2O .

The trip to Trona, Calif., was made with Dr. Paul D. V. Manning, with whom the writer had first visited the plant of the American Potash & Chemical Corp. in July, 1931. (See *Chem. & Met.*, Nov. 1931, pp. 644

ff.) Tremendous progress had been made since that time especially in the development of the process for the recovery of soda products and in the building of many improvements in the plant and community. New air-conditioned offices and laboratories, a clubhouse, swimming pool and dormitories have added to the attractiveness

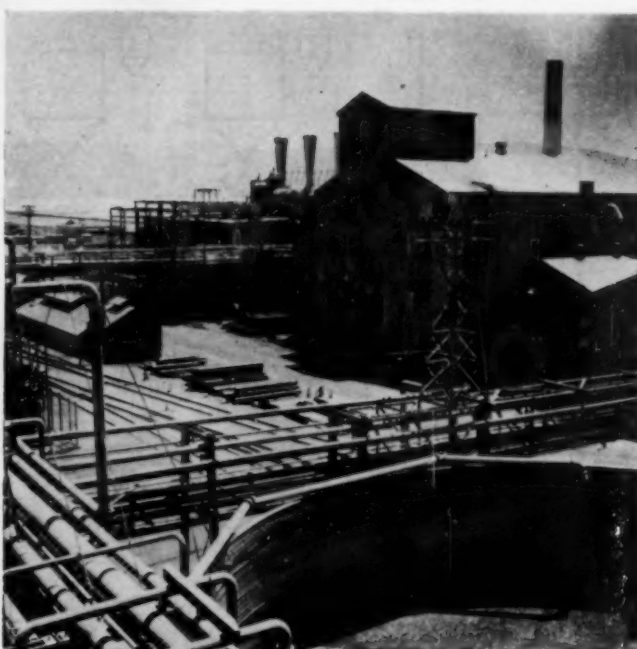
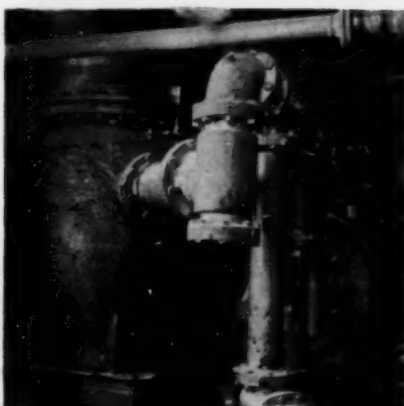
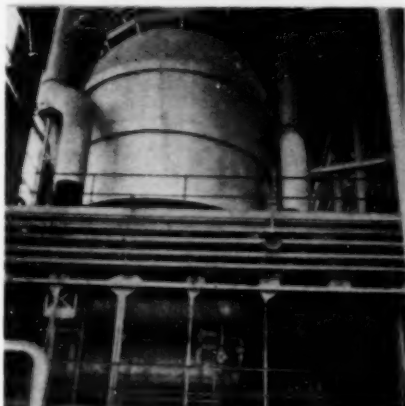
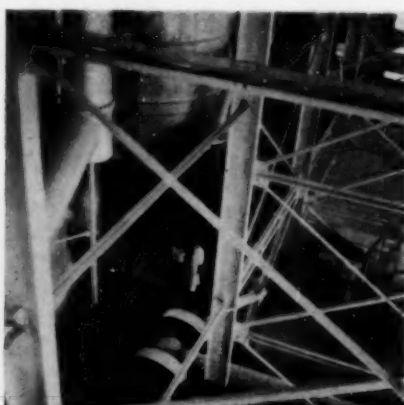
of this man-made oasis in the great Mojave Desert.

Since the publication of the classic monograph on the Searles Lake development by the late Dr. John E. Teeple, and the appearance of a number of articles (see particularly *Chem. & Met.*, May, 1929, pp. 268-72), most chemical engineers are familiar with this company's remarkable application of physical chemistry to industry. Accordingly, it will be reviewed in barest outline at this time.

The Trona process for the manufacture of potash, borax, sodium carbonate and sodium sulphate is essentially one of evaporation followed by fractional crystallization. The composition of the Searles Lake brine which is processed in this manner may be represented as being equivalent to

Percentage by Weight	
Sodium chloride	16.35
Sodium sulphate	6.96
Potassium chloride	4.70
Sodium carbonate	4.70
Sodium tetraborate decahydrate (borax)	2.84
Miscellaneous	0.47
Total salts	36.02
Water	63.98

Group of evaporator details at Trona, and below, exteriors at the Trona, Calif., plant of American Potash & Chemical Corp., showing, from left to right, the borax plant, potash crystallizer building, power plant and soda products building



Some of the liquor from each effect is withdrawn together with the sodium salts formed and passes into a multiple cone salt separator, with one cone for each effect. As the salts descend from cone to cone through orifices in the bottom of each, they are washed with progressively less concentrated solutions and finally with raw brine.

For KCl recovery, a three-stage vacuum crystallizer is used in which raw brine, borax mother liquor and water are all employed as cooling agents for vacuum production. The third stage discharges at 100 deg. F. to a settler, the underflow of which is centrifuged for KCl recovery while the overflow (with the centrifugal filtrate) goes to the borax plant. The KCl crystals pass through oil-fired rotary dryers and are then stored, coarsely crushed, bagged for shipment or shipped in bulk. The KCl mother liquor, on reaching the crude borax plant, is combined with mother liquor from the borax refinery, cooled to 75 deg. F. with ammonia refrigeration and the crystals settled in a Dorr thickener. The thickener underflow is filtered and the crude borax cake sent to the refinery. The filtrate and thickener overflow (the crude borax mother

Some interesting data regarding the plant capacity at Trona are given in the following table:

Steam plant horsepower, operating capacity	26,000
Electric power, kilowatts, generating capacity	16,000
Refrigeration capacity, tons per day	1,800
Cooling towers, gallons condenser water per hour	3,000,000
Evaporator plant, tons water evaporated per day	8,000
Evaporator plant, gallons water evaporated per day	1,930,000
Production, muriate of potash, tons per day	520
Production, borax, tons per day	285
Soda ash, tons per day	150
Sodium sulphate products, tons per day	200
Employees (approximately) ..	1,000

POTASSIUM CHLORIDE AND BORAX (TRONA PROCESS)

Hot brine

Searles Lake brine

Raw brine

Concentrated storage

Hot brine + M.L. 2

Clarifier

Solids to soda products plant

Salt separator

Salts

Hot brine

Vac. filters

Settler

M.L. 1

Dryers

Potash storage, bagging, shipping

Centrifugals

M.L. 3

M.L. 1, M.L. 3 tank

Refrig.

Crystallizer

Thickener

M.L. 2 tank

Filter

Crude borax refining

Refined borax

Key: C, Barometric condenser; E, Evaporator; H, Heater or heat exchanger; M.L., Mother liquor; S, Separator; V.C., Vacuum crystallizer; W, Cooling or dilution water

Products and Byproducts

Being a miscellany of observations and comment—serious and otherwise—about plants, products, and people met in 16,000 man-miles of editorial travel.

WE WERE WARNED!

BEFORE WE DECIDED to have a look at western phosphates from close range, we received this warning from one who had reason to know. "The western phosphate area is plentifully supplied with high-grade phosphate, high-pressure salesmen, high-hat promoters, high-powered politicians, high hopes, high mountains, high waterfalls, highjackers, high-heeled boots, highsteppers and high-proof liquor. Chemical engineers and oysters are not indigenous to such an altitudinous country. If you can find anyone out there who can touch the solid ground of good economics and technology, go to it. But don't say we didn't warn you!"

PIE INSTEAD OF PORK

PERHAPS WE WERE LUCKY, but we did find some pretty substantial citizens around Anaconda and Trail who seemed to know their way about, even at such altitudes. They came from a generation raised on pickhandles, that had learned its mining methods early in life and has successfully applied the same technique to the solution of some mighty tough chemical engineering problems. After that they traveled the long, rocky road to market with their new products.

And we did meet at least one honest phosphate promoter. He had prepared a long and persuasive report in which he recommended that Uncle Sam should spend some \$60,000,000 on a dam and hydro plant in order that his enterprising community might have a duplicate of the T.V.A. metaphosphate plant. When we raised some minor questions and asked about the way we should interpret his conclusion, he wrote us as follows: "You would be safe in regarding my report

as our state's move in the direction of Uncle Sam's pie counter. Merely a sign of the times!"

AGRICULTURAL AMMONIA

SHELL CHEMICAL CO. of San Francisco has developed a novel and interesting outlet for liquid anhydrous ammonia, which in the last two or three years has been sold to farmers in California for the direct ammoniation of irrigation water used for a variety of crops. Successful use is claimed in the raising of citrus fruits, celery, carrots, sugar beets, wheat, rice, lettuce, peaches, berries, grapes, flax and a number of other vegetables. Through the employment of simple equipment ammonia is bubbled into the irrigation water in such small quantity that only a negligible amount is lost by evaporation, dilutions generally not being much over 100 parts per million. The nitrogen of the ammonia is present in the water either as ammonium hydroxide or as salts of the mineral constituents of the water and so is completely available. Contrary to what might be expected, the effect of absorption by the soil is to lower rather than raise the pH, since the action of the soil organisms together with the oxygen of the air is said quickly to produce nitric acid and hence nitrates. An interesting claim for this method of providing nitrogen is that no permanent change in the soil takes place since there is no residual material left after the nitrogen has been exhausted.

PETROLEUM FERTILIZERS

WHEN SHELL CHEMICAL built its ammonia plant at Pittsburg, Calif., it seemed a long way from petroleum refining. Lately that gap has been narrowed considerably as hydrogen production has become much

more important in the synthesis of aviation fuels. Now comes a further demonstration of the close interrelations of the petroleum and chemical industries. Sludge acid, the *bête noir* of the oil refinery, is shipped to the plant at Pittsburg, the emulsions broken, the oil removed, and the purified acid neutralized with synthetic ammonia. The finished product is a good grade of ammonium sulphate with little, if any, color, and no tell-tale odors of its petroleum ancestry.

HOW SECRETS LEAK OUT?

WE WERE WATCHING history being made. Before us in an autoclave a new product was being synthesized. Our accommodating host carefully detailed the complicated process, but asked our pardon because he could not tell us what catalyst was being used. As we turned to leave, one of us called the operator's attention to a leaking gasket through which a material of strangely familiar odor was forcing its way into the atmosphere. Curious to recall what it was, we asked our host, but somehow he had suddenly found business elsewhere in the plant. So the obliging operator answered, "Why, that's the we have to put in to make the process work." When we caught up with our host and reported the conversation, he philosophically observed, "What's the use of trying to keep anything from you fellows? Secrets seem to have a way of leaking out, don't they?"

BORAX SANS EAU

ANOTHER INVENTION mothered by necessity is dehydrated borax or "Pyrobor," as it is called at Trona. A new plant has been built to melt the ordinary borax of commerce ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10 \text{H}_2\text{O}$) in a huge furnace, drive

off the water of crystallization and leave a semi-fused product that is cast in ingots and then ground to a fine powder. In molten form it resembles, but is not exactly, a fused glass. Rather it has a definite crystalline form that can be dissolved in water. It finds its best market with the enamel and glass makers. Approximately 53 lb. of Pyrobor ($\text{Na}_2\text{B}_4\text{O}_7$) will contain the equivalent of 100 lb. of borax in terms of B_2O_3 . Hence it is no longer necessary to pay freight on 47 lb. of H_2O !

HELPING MOTHER NATURE

EVER HEAR OF Soap Lake, Washington? Neither had we until we suddenly found ourselves on its famous shores one hot day this summer while en route from Seattle to Grand Coulee. The first thing to catch our eye was what was very evidently a chemical industry with an intriguing sign, almost as big as the plant, "Mother Nature's Soap Lake Products." Duty—or perhaps it was curiosity—prompted us to enter the showroom where one of M.N.'s comely daughters was persuasively propounding the virtues of Mother Nature's prescriptions. Picking up a handy



J. H. Matson, chief chemical engineer, Mother Nature's Soap Lake Products

little circular, we learned that "Old Soap Lake is the place Ponce de Leon had in mind, where the blessed water cures the ills of all mankind."

Here, we were sure, must be a story for our West Coast issue. So, modestly and slowly, we began to unfold our several and serious ailments to the sympathetic lady. We had gotten no further than mentioning our latest symptoms of nostalgia, when our eyes fell on a dusty bookcase with a whole shelf full of dog-eared copies of—yes, you guessed it—*Chem. & Met.*,

Vol. 41 to date! Realizing then that we were in the near presence of a customer, we somehow managed to ask "Who reads those magazines?" "They belong," we were told, "to our chief chemical engineer. Would you like to meet him?" We would and did.

J. H. Matson, one of Professor Benson's former students at the University of Washington, told us some mighty interesting things about the famous lake and the old Indian legends regarding the curative properties of its waters. Containing 28,266.9 parts per million of total solids of which 14,089.1 are sodium carbonate and 6,348.7 are sodium sulphate,* we were not surprised. It has a soapy feel and when an occasional wind blows across the lake, the white caps foam with real soapsuds—or so we were told. Mr. Matson's job is to bottle up "Mother Nature's Soap Lake Spirit" to sell for 50 cents for 4 oz. or, by evaporation processes, produce the various salt crystals, and "seltzers" in 5-lb. packages for \$1.50 and up. The equipment may have appeared a bit crude and obsolete, but it does the work so well and apparently so profitably that the company has never been quite willing to accept its chief chemical engineer's design for a modern vacuum evaporator, crystallizer and dryer.

Our editorial duty done, we returned to listen to Mother Nature's charming daughter. She was just finishing the last verse with this advice, which we are glad to pass along to *Chem. & Met.*'s readers:

Men, go to Soap Lake if you're skinny or fat!
If you're slow between bases, or can't come to bat!
If your wifey is nervous, or failing in step;
If she's grouchy or naggy, or losing her pep—
Send her to Soap Lake, where the people get well—
Where the water works wonders, but to drink it, is H---!

NO OASIS

CALIFORNIA is more considerate of what its visitors drink. On the way back from Trona when the thermometer in the Buick was hitting 120, we came suddenly to a little rocky spring in the desert. We were hot and thirsty, for we had taken more than our share of those little salty

* According to "U. S. Governmental Analysis of Soap Lake" by H. G. Knight in W.S.P. No. 111, Series 0, Underground Waters 29.



"... with our tongues hanging out"

life-savers, every time we stopped at one of A.P.C.'s many convenient water coolers. Climbing out of the car with our tongues hanging out, what did we find? A big sign—"Warning! Poison water do not use for any purpose!" We climbed right back into the car, but with our tongues still hanging out until we got to the Barstow Bar, 40 miles away.

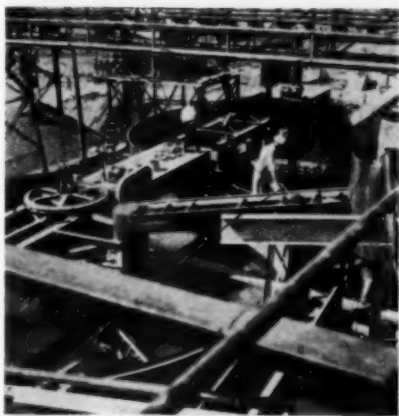
SAND CLASSIFYING AT GRAND COULEE

GRAND COULEE DAM, which will be 4,300 ft. long at the crest, 550 ft. high, and have a bulk three times that of Boulder Dam and four times that of the Great Pyramid, is probably the most stupendous engineering project ever undertaken. The work of civil engineers, its success nevertheless will depend on many sorts of engineering of a high order, not the least of which is found in the sand preparation plant where clarifier type thickeners, hydro-separators, rake and bowl classifiers are being used in the grading of high specification sand sufficient to make the 12 million cubic yards of concrete that will go into the finished structure. Whether this be chemical engineering or metallurgical engineering is beside the point. The fact is that except in size and in the tonnage of solids handled, the equipment is no whit different from that in many a chemical plant and metallurgical mill.

In the construction of the foundation dam which has now been completed, a flow sheet for sand preparation quite similar to that now in construction to supply sand for the main dam was employed. The new set up, which by all odds is the largest for



Above—General view of Grand Coulee sand preparation plant



Left—Dorr bowl classifiers during construction

the purpose in the world, will have a sand throughput capacity of 2,200 tons of solids per hour at 4:1 dilution and will produce three clean size fractions of -4 to $+28$ mesh, -28 to $+48$ mesh, and -48 to $+100$ mesh. The run-of-pit sand, which is too high in the intermediate size range, will thus be fractionated and the fractions recombined to yield a sand of 2.5–3.0 fineness modulus as called for in the concrete specifications.

Following the production of four sizes of gravel by means of vibrating screens and a gyratory crusher, the fines will be washed into three 35-ft. Dorr hydroseparators, each of which will overflow 1,760 tons per day of -100 mesh solids and underflow 15,840 tons of $+100$ mesh material. The underflow will pass to three 14 x 30-ft. Dorr rake classifiers in parallel which will discharge a total of 28,320 tons of -4 to $+28$ mesh sand to the storage pile, and 19,000 tons of finer material to the next separation stages. These consist of a 16-ft. and a 25-ft. diameter Dorr bowl classifier in series, with either of which a 13-ft. bowl classifier may be put in parallel. The first will discharge 10,080 tons of -28 to $+48$

mesh solids, and the second, 4,560 tons of -48 to $+100$ mesh material to storage per day. The combined overflows from the third-stage classifier and the three hydroseparators, containing some 9,840 tons of -100 mesh sand and about 95 per cent of the water originally supplied to the washing plant, will flow to three 125-ft. Dorr clarifiers in which the water will be recovered for return to the washing plant and from which the fines will be pumped to waste.

WESTERN POWER

(Continued from page 473)

pumping, the balance will go to market. Discussions for its ultimate marketing have suggested the creation of a Columbia River Authority or Administration which would take over both Grand Coulee and Bonneville, as well as any future developments aimed at utilizing the 8,000,000 kw. of potential capacity available on that stream. Grand Coulee power rates will naturally depend upon the final allocation of investment costs. Preliminary analyses have indicated that they may be lower than those quoted for Bonneville.

In the central Pacific Coast region embracing northern California, the federal contribution to abundant power consists of only one project—the Central Valley development with Shasta Dam on the upper Sacramento River as the chief power source. This is primarily a flood control and water conservation project with power as an important byproduct which is ex-

pected to bear much of the cost. Important to industry is the plan to increase the fresh water supply to the heavy manufacturing area on upper San Francisco Bay. The initial power development will consist of two 70,000-kw. generating units with an ultimate capacity of 350,000 kw. Probable date of completion of the project is 1941. No provisions have been made for the marketing of this power except for a 140-mile transmission line from the dam to Pittsburg on San Francisco Bay. Overtures have been made by the Pacific Gas and Electric Company, the principal serving utility in this region, to take over the entire output on a price basis equal to its cost of power from other sources.

Noteworthy in this area is a development of utility-industry cooperation whereby Pacific Gas and Electric is constructing three 40,000-kw. steam-electric generating stations adjacent to the Shell, Union and Associated oil refineries in the bay region. These will consist of modern high-pressure, high-temperature stations which will furnish both power and steam to the refineries and which will utilize refinery sludge under their boilers.

Boulder Dam has been supplying large blocks of power to southern California for two years. Two transmission circuits with a combined capacity of 240,000 kw. are being operated by the Los Angeles Bureau of Power and Light and a third circuit is to be constructed within the next year. Southern California Edison Company will have its transmission line from the dam in operation early in 1939. Other lines have been built from the dam into southeastern Nevada with plans for extensions into other sections of that state where natural resources are abundant as conditions require.

Power always has been and will continue to be one of the Far West's most abundant natural resources, available over wide areas at low cost. The chemical process industries which look to this region for new markets and new opportunities will find a power industry that is resourceful, cooperative and one which has been free from the charges which have been made against the industry elsewhere. The private utilities have a tremendous stake in the region which they feel can be integrated and coordinated with the huge supplies of federal power which are being made available. The main problem is one of marketing—and in this case it is a sellers' market.

A New Index for Chemical Industry

Based on manufacturing activities within the industries which are the principal consumers of chemicals, Chem. & Met. presents a newly devised index as a yardstick for the measurement of monthly consumption of chemicals.

WITH THE exception of a few commodities, production data for chemicals are not currently available and the rate of productive operations cannot be accurately measured. Because of the wide diversity in chemical manufacture, trade estimates bearing on the varying status of the industry, may be based on knowledge which has particular but not general application. Activities in the industries which are the principal consumers of chemicals, however, may be expressed in terms of approximate chemical consumption by establishing base factors and applying to them the statistics which come monthly from government agencies, trade associations, etc. In interpreting these statistics *Chem. & Met.* has evolved a Weighted Index for Chemical Consumption which will be carried on from month to month.

Basis of Index

Because the latest authoritative figures for production of chemicals are contained in the U. S. Bureau of Census reports covering the output for 1935, that year has been taken as the

base period. Consumption of chemicals in 1935 has been allocated among the following 13 industries:—fertilizer; pulp and paper; glass; petroleum refining; iron and steel; rayon; textiles; paint, varnish, and lacquer; coal products—this is confined to production of sulphate of ammonia but indirectly reflects on byproduct coke and steel production—; explosives; plastics; leather, glue and gelatine; and rubber. Selection of these industries was influenced by the fact that they offer the largest outlets for distribution of chemicals and current statistics on their operations are available. Manufacture of soap is not included because reliable data on current production is not obtainable. The chemical industry—which is itself the largest consumer of chemicals—is not included because its products, in their final form, eventually find their way into the various consuming industries which are included in the index.

Allocation of chemicals to the various consuming industries for the base year 1935 is on the authority of the Bureau of the Census, *Chem. & Met's*

studies on chemical distribution, and association and private estimates. The Bureau of the Census, for instance, gives a breakdown for materials consumed in fertilizer manufacture in 1935. It also gives incomplete returns for chemical consumption in some other lines and, where available, these figures have been used in this compilation. The chemicals allocated include only those manufactured within the chemical industry and reported in the Census returns.

This allocation is not 100 per cent complete but it covers such a large percentage of each specified indus-

Industry	Tons	Per Cent of Total
Fertilizer	1,322,000	19.47
Pulp and paper.....	841,000	12.39
Glass	718,500	10.58
Petroleum refining.....	713,370	10.51
Paint, varnish and lacquer	702,735	10.35
Iron and steel.....	488,350	7.20
Rayon	426,585	6.29
Textiles	414,930	6.11
Coal products.....	390,000	5.74
Leather, glue and gelatine	268,120	3.95
Explosives	245,350	3.62
Rubber	147,575	2.17
Plastics	110,100	1.62
Total	6,788,615	100.00

Chem. & Met's Weighted Index for Consumption of Chemicals Based

Industry	1937												
	1932	1933	1934	1935	1936	1937	Jan.	Feb.	March	Apr.	May	June	July
Fertilizer	11.64	17.78	18.91	19.47	22.57	28.93	29.90	30.16	34.08	29.56	26.52	22.76	22.22
Pulp and paper.....	9.34	10.80	11.15	12.39	14.31	15.96	16.06	15.53	17.61	17.83	17.83	16.94	16.34
Glass	6.03	7.71	8.21	10.58	12.45	13.61	12.82	13.13	13.73	14.31	15.58	15.38	13.76
Petroleum refining.....	8.93	9.37	9.74	10.51	11.61	12.87	12.29	11.09	12.32	12.21	13.11	12.96	13.68
Paint, varnish, and lacquer	5.96	6.80	8.54	10.35	10.77	11.33	10.16	10.07	12.82	15.01	14.69	13.52	11.69
Iron and steel.....	3.10	4.46	5.43	7.20	8.00	9.21	10.20	10.32	10.80	10.94	11.06	9.10	9.82
Rayon	3.29	5.23	5.09	6.29	7.01	7.97	9.18	8.80	9.94	9.62	8.84	7.96	7.70
Textiles	5.13	6.40	5.52	6.11	7.44	7.62	8.73	8.52	9.65	9.12	8.44	7.63	7.37
Coal products.....	3.58	4.22	4.88	5.74	7.46	9.66	10.40	9.53	10.69	10.42	10.71	9.56	10.32
Leather, glue and gelatine	3.11	3.55	3.65	3.95	4.08	4.10	4.56	4.92	5.02	4.63	4.42	4.12	4.10
Explosives	2.76	3.04	3.74	3.62	4.60	4.71	3.97	4.12	6.25	6.11	4.66	4.28	3.98
Rubber.....	1.57	1.86	2.10	2.17	2.58	2.56	2.82	2.79	2.92	2.80	2.88	2.90	2.56
Plastics.....	.64	.78	1.09	1.62	1.97	2.28	2.32	2.44	2.62	2.60	2.52	2.44	2.34
	65.08	82.00	88.05	100.00	114.85	130.81	133.41	131.51	148.45	145.16	141.26	129.55	125.88

try's total that the relative weighting of each should be substantially correct.

The accompanying tabulation gives the tonnage of chemicals as allocated to the several industries together with the relative importance of the respective industries as consumers.

With total chemical consumption in the specified industries thus determined, current monthly data are referred to the corresponding 1935 monthly average and the base index number for the industry in question—which is its standing in the percentage column of the table—is moved up or down accordingly.

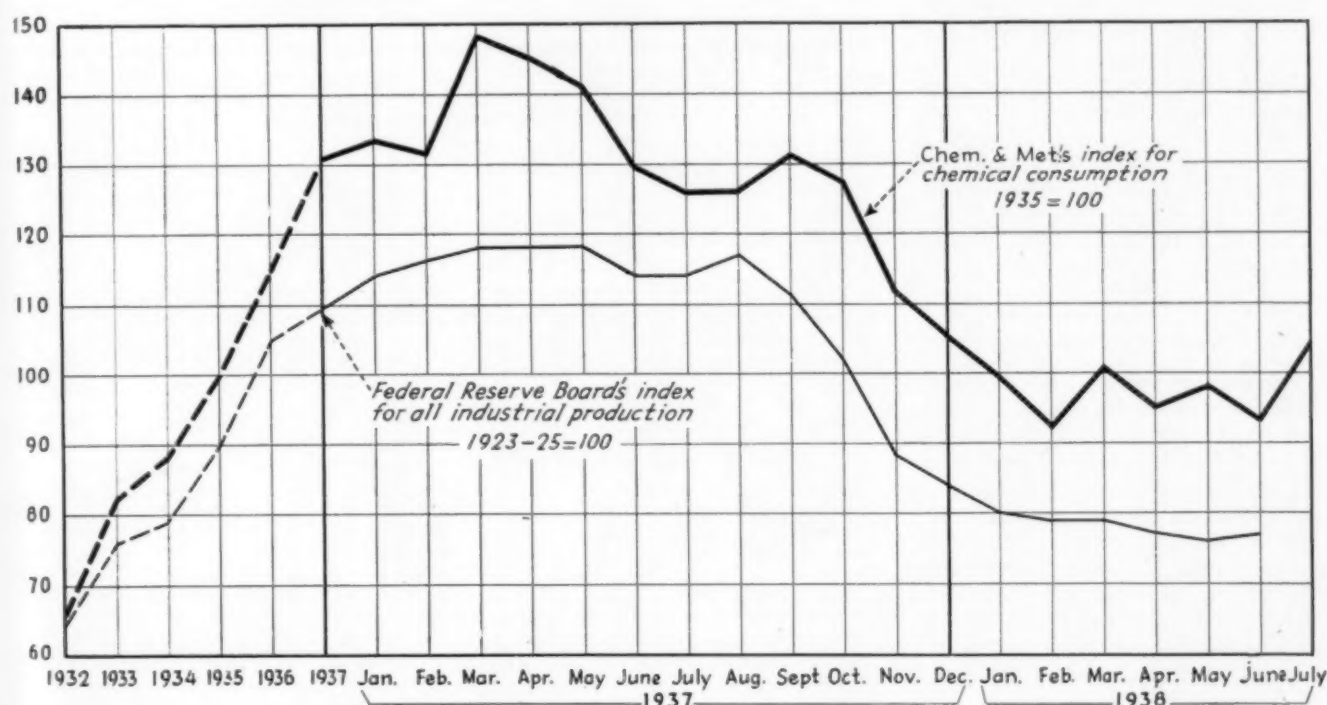
Monthly data include: production of acid phosphate, pulp, plate glass, glass containers, rayon, sulphate of

ammonia, reclaimed rubber, and nitrocellulose and cellulose acetate plastics. Consumption of crude rubber, cotton, wool, silk, rayon, petroleum runs to stills, shipments of explosives, and sales of paint, varnish and lacquer. These data are supplemented by Federal Reserve Board indexes and by trade estimates.

In the case of industries comprising different branches subject to varying economic influences, proper weighting is given to each branch. For example, glass manufacture, in this compilation, has been divided into six general divisions with containers representing approximately 45 per cent of the entire industry.

From industry statistics already made public it is clearly evident that

a wide difference exists in the degree to which individual chemicals have been affected by the decline in general business this year. As an illustration, petroleum refining operations were on a larger scale in the first quarter of this year than in the corresponding period of 1937. Production of kraft pulp also has held up well which partly accounts for the continued good demand for such chemicals as chlorine and salt cake. An index charting monthly developments in industry should find practical application in directing attention to fields where sales efforts might best be directed. Also it might aid as a medium for comparing rates of production and consumption with their indication of inventory trends.



on Productive Activities in Principal Consuming Industries

1937					1938							Industry
Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	
28.85	27.32	30.57	29.80	35.44	29.87	25.04	25.39	22.39	22.61	19.38	28.50	Fertilizer
16.87	16.25	15.31	13.27	11.66	12.31	12.59	14.12	12.95	12.67	13.88	15.40	Pulp and paper
14.74	14.45	14.02	11.92	9.45	7.84	7.26	8.50	8.47	8.79	8.65	8.48	Glass
13.74	13.51	13.71	13.00	12.84	12.78	11.51	12.51	12.49	12.95	12.25	12.86	Petroleum refining
11.46	11.20	10.65	8.48	6.28	7.18	7.35	9.98	11.28	11.96	11.02	9.10	Paint, varnish, and lacquer
10.45	9.14	7.39	6.14	5.17	4.24	5.40	6.04	6.10	5.30	4.20	5.40	Iron and steel
7.90	7.72	6.68	5.98	5.28	4.86	4.47	4.78	4.36	4.39	4.37	4.74	Rayon
7.53	7.32	6.40	5.69	5.02	5.19	5.19	5.81	5.06	5.15	5.45	5.96	Textiles
10.66	10.29	9.37	7.49	6.45	5.59	4.96	5.39	5.12	4.77	4.17	4.55	Coal products
4.38	4.05	3.51	2.79	2.68	3.15	3.69	3.87	3.62	3.47	3.11	3.58	Leather, glue and gelatine
4.50	5.01	5.08	4.54	3.98	4.05	3.59	3.42	3.35	3.63	3.71	3.38	Explosives
2.48	2.57	2.33	1.98	1.71	1.57	1.28	1.59	1.48	1.53	1.63	1.76	Rubber
2.41	2.36	2.20	1.95	1.14	.99	.96	1.17	1.16	1.11	1.10	1.18	Plastics
135.97	131.19	127.22	113.03	107.10	99.62	93.29	102.57	97.83	98.33	92.92	104.89	

WESTERN PROGRESS
(Continued from page 461)

rection of Dr. E. C. Williams. The large and modern laboratory building is backed by impressive facilities devoted to pilot plant and small scale operations. The processes evolved include those for production of solvents, alcohols, ketones and new unsaturated chlorides or other derivatives. Development work does not end with the devising and trying out of the process. It is carried into limited commercial production and the new products are marketed up to the point where the worth of the process and the marketability of the product are demonstrated. Then production is taken over by the Shell Chemical Co.

In commercial production at Dominguez, near Los Angeles, Shell Chemical Co. is making acetone, diacetone alcohol, secondary butyl acetate, secondary butyl alcohol, methyl ethyl ketone, isopropyl alcohol, isopropyl acetate, isopropyl ether and mesityl oxide. Isopropyl alcohol is being used in substantial quantities in the production of pectin from citrus wastes. In the near future, it is expected that this large solvent plant will produce other esters and acetates for the lacquer industry.

What of the Future?

Considering all of these factors, including natural resources and power, this writer is of the opinion that industrial growth in the West during the next decade will trend in the following directions: (1) Petroleum and natural gas as raw materials for the chemical industry will continue to grow in importance because the West has a vast source of such materials and water transportation of finished products to all parts of the world is easy and cheap. (2) Utilization of the abundant and increasing supplies of electric energy will undoubtedly result in a great development of electrochemical and electrometallurgical industries. Production of light metals for airplane manufacture, now largely a western industry, would seem to favor the production of aluminum from imported bauxite and magnesium from domestic raw materials. Electric furnace steel and alloy production is potentially important. Research on manganese and chromium processes seem to hold important possibilities. (3) In the Pacific Northwest, it is likely that less wood will be wasted for fuel and more used as chemical

raw material, which emphasizes the possibility of establishing rayon and other cellulose industries. (4) With increased agricultural activity, the manufacture of new fertilizers and insecticides will become of more importance. Likewise, we can confidently look forward to the development of chemical industries that will utilize these agricultural surpluses as raw materials.

In addition to these four broad trends, there are others of more specific interest to the chemical process industries. It has been possible to include only a few of these in this article and, in closing, the writer would like to leave this suggestion: Any company in the process industries, or any chemical engineer or executive seriously interested in studying opportunities for the further in-

dustrial development of the West, will find here many private and public agencies that are most desirous of furnishing information and data.

To the following of these organizations and individuals, this writer wishes to express his grateful appreciation: George W. Malone and R. N. Miller, Industrial West, Inc., San Francisco; Walter W. Bradley, California State Mining Bureau, San Francisco; Earl K. Nixon, Oregon State Department of Geology and Mineral Industry, Portland; Thomas B. Hill, Supervisor, Washington Department of Conservation and Development and R. K. Tiffany, Washington State Planning Council; Olympia, Wash.; and to the industrial departments of the Chambers of Commerce in Los Angeles, Calif., Portland, Ore., and Seattle, Wash.

California's Mineral Production, 1937*

Substance	Amount	Value	Number of Properties
Bentonite.....	8,425 tons	\$140,261	6
Borates.....	326,099 tons	6,206,619	5
Brick and hollow building tile.....		3,083,902	43
Cement.....	12,072,062 bbl.	16,546,229	10
Chromite.....	1,918 tons	20,830	7
Clay, pottery.....	354,669 tons	705,200	57
Copper.....	10,512,500 lbs.	1,272,013	(^c)
Dolomite.....	12,371 tons	24,603	4
Feldspar.....	2,686 tons	10,930	3
Gems.....		2,075	5
Gold.....	1,174,578 fine oz.	41,110,230	1,751
Granite.....		207,738	17
Gypsum.....	186,160 tons	384,431	5
Iron ore.....	5,490 tons	29,340	4
Lead.....	2,402,110 lbs.	141,724	(^c)
Lime.....	69,532 tons	681,277	25
Limestone.....	351,755 tons	830,562	
Magnesium salts.....	7,733,918 lbs.	316,669	3
Marble.....		23,667	6
Mineral water.....	18,309,729 gal.	1,130,810	38
Natural gas.....	323,883,714 M cu. ft.	19,859,865	(^b)
Petroleum.....	238,558,562 bbl.	237,845,872	
Platinum.....	530 oz.	23,704	(^c)
Pumice and volcanic ash.....	10,392 tons	79,005	17
Quicksilver.....	9,995 flasks	837,789	65
Salt.....	370,431 tons	1,044,325	12
Sandstone.....		15,680	6
Silver.....	2,888,265 fine oz.	2,234,073	(^c)
Silica.....	84,313 tons	348,987	5
Slate.....		32,572	7
Soapstone and talc.....	29,657 tons	347,772	9
Soda.....	153,685 tons	1,461,057	4
Stone, miscellaneous.....	(^c)	16,917,683	382
Tungsten.....	611 tons	782,187	8
Zinc.....	39,643 lbs.	2,577	(^c)
Unapportioned (^d).....		6,813,693	(^d)
Total value.....		\$361,515,951	

* From California State Division of Mines.

(^a) There were 913 lode mines and 838 placer mines, not including snipers, prospectors, and various individuals who sold small lots.

(^b) There was an average of 12,954 producing wells.

(^c) Includes macadam, crushed rock, ballast, rubble, rip rap, sand and gravel.

(^d) Includes barite (2), bituminous rock (2), bromine (2), calcium chloride (2), carbon dioxide (2), coal (3), diatomite (6), fluorspar (1), iodine (2), magnesite (2), mica (2), mineral paint (3), potash (1), pyrite (1), sillimanite group (2), tube mill pebbles (1), sulphur (1), zircon (1).

(^e) Included with gold.

Chemical Engineer's BOOKSHELF

Pacific Coast Raw Materials

THE AVAILABILITY in the Pacific Coast area of certain raw materials and facilities for industrial growth is discussed at length in the following reports published this year by the War Department, Office of the Division Engineer, North Pacific Division, 523 Pittock Block, Portland, Oregon:

Iron—Available Raw Materials for a Pacific Coast Iron Industry, Vol. V. By E. T. Hodge, consulting geologist. Mimeographed, 106 pp. \$1. (Four volumes previously published, \$5. Complete set of five volumes, \$6.) Describes iron ore deposits located in Washington, Idaho and Oregon. A feature is a description of the Ruzicka process for making metallurgical coke from wood, with the by-products obtainable.

Manganese—Preliminary Report on Some Northwest Manganese Deposits, Their Possible Exploration and Uses. By E. T. Hodge. Mimeographed, 91 pp. 75 cents. Many of the low-grade deposits in southwestern Oregon and the Olympic Peninsula, Washington, are described. Includes discussion of the technology of low-grade manganese ore reduction, uses and market for manganese, foreign sup-

plies, imports, and various domestic statistics.

Magnesia, silica, limestone, clay—Market for Columbia River Hydroelectric Power Using Northwest Minerals. By E. T. Hodge. Mimeographed. Section I—Northwest Magnesia Ores. Two volumes, 364 pp. \$3.75. Section II—Northwest Silica Materials. Two volumes, 408 pp. \$3.75. Section III—Northwest Limestones. Two volumes, 621 pp. \$7. Section IV—Northwest Clays. Four volumes, 1079 pp. \$12.50. With reference to their respective subjects these sections discuss varieties and occurrences, economics and technology of production, uses, present and future markets, competitive world supplies, possible electric power applications in processing, uses of the product requiring electric power.

Zinc and cadmium—The Feasibility of Electrolytic Zinc and Cadmium Production in the Lower Columbia River Area. By Raymond M. Miller, metallurgical engineer. Mimeographed, 79 pp. 75 cents. Discusses suitability of the Columbia River area as a location for an electrolytic zinc and cadmium plant. Briefly outlines processes and reviews the industry and

its present trend. Some discussion is also devoted to the fume nuisance problem, pointing out the local situation with respect to outlets for the products and byproducts of sulphur gas recovery.

Ferro-alloys—Feasibility of the Production of Ferro-Alloys in the Columbia River Area. By Raymond M. Miller. Mimeographed. 50 cents. Covers the three principle ferro-alloys: ferrosilicon, ferromanganese, and ferrochrome, with a study on the production of the rustless chrome steels. Transportation facilities, power supply, and necessary raw materials available in the Columbia River area are described.

Rayon—Economic Possibilities for Rayon Production in the Columbia River Area. By William C. McIndoe, industrial chemist. Mimeographed, 198 pp. 50 cents. Covers the rayon yarn industry, its historical background and present status in the United States. Technology of the viscose, cellulose acetate, and cuprammonium processes is described, and the availability and costs of raw materials in the Northwest is pointed out along with other economic factors of production.

POLYMER GASOLINE

PRINCIPLES OF MOTOR FUEL PREPARATION AND APPLICATION, VOL. I. Second edition. By Alfred W. Nash and Donald L. Howes. Published by John Wiley & Sons, Inc., New York City. 628 pp. Price, \$8.

Reviewed by W. L. Nelson

THE PUBLICATION of a second edition when the first edition appeared only in 1935 is proof of the popularity of this book. Like its forerunner, the new edition is confined largely to a study of the research and scientific developments of motor fuel manufacture rather than actual plant technology, although it does make more of an attempt to point out practical applications. Some of the work discussed will eventually become a part of plant operations, but the main bulk of it will never see commercial application and will be relegated to reference libraries.

No vital changes are incorporated in

the second edition except the addition of a comprehensive chapter on pyrolysis and polymerization processes. The other chapters, in fact, are slightly shorter than formerly. Because no similar well organized and brief presentation of the polymerization processes has been published, the new chapter will be welcomed by most petroleum technologists, and to anyone contemplating an investigation of these processes it will be worth the price of the book.

Although the whole book leans somewhat toward a recital of scraps of information about each important piece of current literature, it does not err in this respect as greatly as most other works. Unlike many of their contemporaries, the present authors assume some responsibility in deciding which processes and studies are of most importance and thus organize their subject into something that is significant to the multitude of ordinary technical men and engineers. From this standpoint, the reviewer feels

that the 93-page outline of polymerization processes is of greater general value than other far more complete books that are available.

PHOTOELECTRICAL AIDS

PHOTOELEMENTS AND THEIR APPLICATIONS. By Bruno Lange. Translated from the German by Ancel St. John. Published by Reinhold Publishing Corp., New York City. 297 pp. Price, \$5.50.

Reviewed by M. E. Clark

WRITTEN in a not-too-technical fashion, this book is designed to serve the purposes of people in many walks of life. It is written in two parts, the first historical and theoretical, designed "to present proof that the same fundamental photoelectric process underlies the Becquerel effect, the crystal photoeffect, and the barrier-layer photoeffect."

The second part of the volume deals with construction, performance, applications, shortcomings, and possibilities of

various types of photoelements. Chemical engineers will find that photocells can be used in laboratory and plant to increase accuracy, promote efficiency and insure safety. Camera fans will be interested in a chapter dealing with exposure meters of simple, built-in, coupled and copying types.

GAS DIRECTORY

BROWN'S DIRECTORY OF AMERICAN GAS COMPANIES. 1938 Edition. Published by Robbins Publishing Co., Inc., New York, N. Y. 635 pp. Price, \$25.

Reviewed by *R. S. McBride*
THIS ANNUAL VOLUME presents the usual complete listing of operating gas companies and the parent holding companies connected with the utility business, as well as the usual list of by-product coke oven plants, state utility commissions, and gas associations. As this edition represents a well-established service which has now operated for 51 years, little review is required of the volume. It has an important place on the reference shelf of every chemical engineering firm dealing extensively with the gas or coke industries.

RECENT BOOKS AND PAMPHLETS

Transactions of the Institution of Chemical Engineers (British), Vol. 15. Institution of Chemical Engineers, 56 Victoria St., Westminster, London, S. W. 1. 260 pp.

Technical Association Papers, 1938. Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York, N. Y. 460 pp. text. Ninety-two papers and addresses presented before T.A.P.P.I., during 1938.

Experiments in Organic Chemistry, by L. J. Desha and L. H. Farinholt. McGraw-Hill Book Co., New York, N. Y. 233 pp. \$1.75. Laboratory companion to Desha's textbook, "Organic Chemistry" (reviewed in *Chem. & Met.*, Dec. 1936), this manual follows the parallel study of aliphatic and aromatic compounds as adopted in the textbook and contains frequent references to the appropriate sections of the text. The book includes the standard preparations for an introductory course.

Modern Rubber Chemistry, by Harry Barron. Chemical Publishing Co., of New York, Inc., New York, N. Y. 342 pp. \$7.50. Written particularly for the man not actively engaged in the field of rubber chemistry, this book is a study of the structure and chemical and physical aspects of rubber and its manufacturing processes.

Tripoli Deposits of Western Tennessee and Mississippi, by E. L. Spain, F. E. Vestal, F. A. W. Davis, and Martin Johnson. Geologic Bulletin No. 8, Tennessee Valley Authority, Knoxville, Tenn. 18 pages. Gives location and character of tripoli deposits in Tennessee and Mississippi; also processing technology and uses of tripoli.

Cours de Chimie Industrielle, Vol. V, by G. Dupont. Published by Gauthier-Villars, Paris, France. 270 pages. 70 fr. This volume on the organic industries completes Professor Dupont's five-volume course in industrial chemistry. The book presents an up-to-date discussion of the industrial chemistry involved in the making of dyes, tanning materials, pharmaceuticals, essential oils and perfumes, resins, rubber, paints and varnishes, and photographic materials.

HEATING, VENTILATING AND AIR CONDITIONING GUIDE, 1938. Published by the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York City. 1,268 pages. Price, \$5.

NEW AND REVISED material on refrigerants and air drying agents, cooling load determinations and design of central cooling and dehumidifying systems is included in the new edition of this familiar technical handbook and buyers' guide.

THE FLUORSPAR INDUSTRY OF THE UNITED STATES WITH SPECIAL REFERENCE TO THE ILLINOIS-KENTUCKY DISTRICT. By Paul Hatmaker and Hubert W. Davis. Published by State Geological Survey, Urbana, Ill., in cooperation with U. S. Bureau of Mines. 128 pp. Price, 50 cents.

THIS JOINT PUBLICATION of the U. S. Bureau of Mines and Illinois State Geological Survey presents a national outlook despite the special emphasis on the Illinois-Kentucky area. It reviews the occurrence, methods of production, beneficiation, international trade and utilization problems.

Koks—Ein Problem der Brennstoffveredlung, by Heinz Kurz and Fritz Schuster. Verlag von S. Hirzel, 2 Koenigstr., Leipzig C 1, Germany. 382 pages. 21.40 RM. A comprehensive volume on the technology of the coke and gas industry. Well illustrated with drawings and photographs.

The Ringstrom Three Dimensional System of the Atoms and the Theory of Atomic Integration, by Adolph B. Ringstrom. Vega Publishing Co., 1579 Milwaukee Ave., Chicago, Ill. 87 pages. An interesting new three dimensional arrangement of the atomic system which provides a place for isotopes and predicts a number of new chemical elements.

Geology and Ore Deposits of the Warren Mining District, Idaho County, Idaho, by John C. Reed. Pamphlet No. 45, University of Idaho, Moscow, Idaho. 65 pages.

La Technique des Industries Chimiques. Science et Industrie, 29 Rue de Berri, Paris, France. 258 pages. 65 fr. An excellent collection of 39 articles reviewing the technology of various branches of French chemical industry. The articles are written by French engineers and chemists engaged in the fields covered and contain a large amount of good technical information.

Recent Advances in Volumetric Chemical Analysis, by H. B. Kellogg. Lefax, Inc., Philadelphia, Pa. 208 pages. Ring binder, \$3; paper cover, \$2. A collection of selected volumetric methods for rapid industrial analyses. The methods are given in considerable detail and in general require only an elementary knowledge of analytical chemistry. Literature reference through 1936 are given.

Chemie in Deutschland, by Claus Ungewitter. Junker & Dunnhaupt Verlag, Berlin, Germany. 143 pages. A glance into the past and future of Germany's chemical developments.

La Chimie des Vitamines et des Hormones, by M. Joseph Sivadjan. Gauthier-Villars, Paris, France. 239 pages. 50 fr. Gives the history, constitution, preparation, synthesis and properties of the various vitamins and hormones.

Hydrophobic Colloids. Nordemann Publishing Co., Inc., New York City. 180 pages. \$2.50. Papers and discussion from a symposium on the dynamics of hydrophobic suspensions and emulsions held at Utrecht in November 1937 under the auspices of the colloidal chemistry section of the Nederlandsche Chemische Vereeniging. Printed in English.

Elastic Properties of Non-Ferrous Metals and Alloys, by J. McKeown and E. D. Ward. British Non-Ferrous Metals Research Assoc., Regnart Bldg., Euston St., London, N. W. 1. 35 pages. 6s. Tabulation of elastic properties of 219 non-ferrous metals and alloys.

Feuerfeste Baustoffe, by Claus Koepel. Verlag von S. Hirzel, 2 Koenigstr., Leipzig C 1, Germany. 296 pages. 17 RM. Properties and production of siliceous refractory materials.

American Wool Handbook, by Werner Von Bergen and Herbert R. Mauersberger. American Wool Handbook Co., 303 Fifth Ave., New York City. 864 pages. \$3.95 in U. S. and Canada; \$4.75 elsewhere. This is the first edition of a new technical handbook concerning the growing of wool, its marketing, grading and use in the woolen and worsted trade. Sections on dyeing, bleaching, printing, dry finishing, and chemical and physical testing will be of value to textile chemists and engineers.

The Structure of Steel Simply Explained, by E. N. Simons and E. Gregory. Prentice-Hall, Inc., New York City. 115 pp. \$2. A technical journal-ist and prominent English metallurgist have collaborated here to produce a highly readable and understandable book on metal structure. It explains in language which is simple—yet remarkably within the limits of scientific accuracy—the general mechanisms and effects of alloying, heat treating and corrosion of steel. Highly recommended for non-technical readers.

Chemical Engineering Group Proceedings, Vol. XIX, 1937. Society of Chemical Industry, 56 Victoria St., London, S. W. 1. 138 pp. 21 s.

Les Vitamines et les Hormones. Gauthier-Villars, 55 Quai des Grandes-Augustins, Paris, France. 482 pp. 120 francs. Papers and discussions of vitamins and hormones as presented at the Sixth Council of Chemistry of the Institut International de Chimie Solvay, October, 1937.

The Cracking Art in 1937, by Gustav Egloff, Martha M. Doty and Jane F. Jordan. Universal Oil Products Co., Chicago, Ill. 397 pp. Bibliography, patents and condensed review of petroleum cracking during 1937.

BRITISH GOVERNMENT PUBLICATIONS

Obtainable from British Library of Information, 270 Madison Ave., New York City. Prices include postage in U. S.

Gypsum, Anhydrite, Celestine and Strontianite. Geological Survey of Great Britain. Working of British calcium and strontium sulphate mines; includes output, values and estimated reserves. 98pp. 80 cents.

Alkali etc. Works. Seventy-Fourth Annual Report by the Chief Inspectors. Ministry of Health. Reports on smoke abatement and noxious fumes during 1937 at 980 works involving the operation of 1,835 separate processes. 56 pp. 35 cents.

The Morgan Rotary Retort, Report of Test by the Director of Fuel Research. Department of Scientific and Industrial Research. Describes carbonization of bituminous coal by mixing in a rotating retort with red-hot coke. 22 pp. 30 cents.

Your Plant NOTEBOOK

GAGING LIQUIDS OF VARYING DENSITY WITH AN ADJUSTABLE DIRECT-READING MANOMETER

By WILLIAM S. GILFOIL *
Arkansas Fuel Oil Co.
Shreveport, La.

DESCRIBED herein is a pneumatic type gage modified to be direct reading for liquids of different specific gravities. Although designed for blending oils it is equally useful for other materials, being simple, accurate, and a means of cutting costs.

In our particular case the primary purpose of the gage was to obviate the necessity for having one man up-stairs to watch our blending kettles and another down-stairs to attend to the pumps and supply manifold. Among the advantages, we found that it saved time in that it was unnecessary to stop stirring the kettles in order to gage their contents.

It is necessary to blend lubricating oils to close viscosity specifications and sufficient accuracy can not be obtained with a vertical mercury manometer, unless a vernier is used. As the depths of oil to be gaged ran as high as 100 in., it was not desirable to have an oil or water manometer. To secure the necessary accuracy without an excessive column length, it was decided to use an inclined mercury column, at such an angle that there would be a 1:4 ratio between column length and oil depth. As the angle of inclination is determined by the ratio of specific gravity of the liquid being measured to that of the liquid in the manometer, by varying this angle we were able to make the manometer read directly in inches of the liquid being measured.

The accompanying drawing indicates the construction of the gage and shows a detail of the mercury reservoir. A manifold is shown for connecting to several kettles.

It is necessary to change the angle of inclination without changing the zero reading of the instrument. Rather than to have a flexible connection in the mercury column, I made the mercury reservoir in the form of a horizontal cylinder rotating about its axis, with the zero point of the mercury column at the center of rotation (see accompanying detail). The mercury reservoir was made large enough that the accuracy of the

readings would not be appreciably affected by the change in cross-sectional area of the mercury as it rose or fell in the reservoir.

The manometer tube is supported on a wooden arm with a scale 25 in. long, divided into sixteenths of an inch so that one division will be equal to $\frac{1}{4}$ in. of oil. The tube is bent upward at the top to prevent blowing out the mercury and the entire apparatus is best mounted over a trough in case mercury is ever blown out by careless handling.

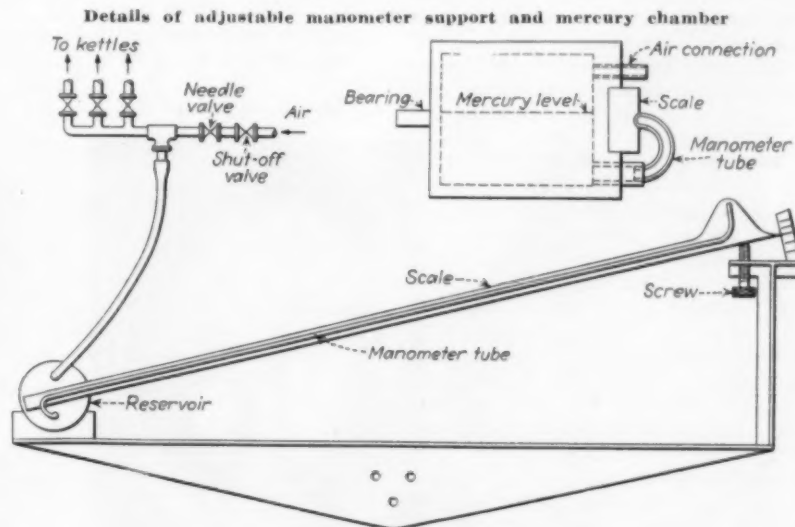
To indicate the inclination the wooden arm is brought to a point against a fixed arc, and rests on an adjusting screw for changing the angle. If the level of the mercury in the reservoir were constant, it would be a simple matter to calculate the proper angles for liquids of different densities, but as it is not, the simplest expedient is to calibrate the scale by filling the kettle to a definite mark with several oils or other liquids of known density and mark the scale at the several angles which gives correct readings on the manometer tube. It is convenient to calibrate the kettle with liquids at room temperature and to mark the uncorrected gravity on the arc. Then in use, if the

pointer is set at the corrected gravity, the gage will indicate the depth in inches at standard temperature regardless of the actual temperature and depth of liquid in the kettle.

In blending two liquids of different gravity, the pointer is set at the gravity of the finished product, and the inches of each material as given to the compounder are not the true gages but theoretical inches arrived at by using the weight percentage of the blend instead of the volume percentage. Thus, in making 100 in. of an oil of 25 gravity, containing 48 per cent by volume or 46 per cent by weight of stock "A", the blender would run in "A" to 46 in. on the gage, and "B" to 100 in., with the pointer set at 25 gravity. When air is used to stir the kettle while blending, the apparent depth will be more than 100 in. of oil but the manometer will register only 100 in. as the hydrostatic pressure is unaffected.

For using one instrument with a number of kettles, a manifold is used (see Gilfoil, *Chem. & Met.*, Nov., 1935, p. 571), with a pressure tube leading to a point $\frac{1}{4}$ in. from the bottom of each kettle. A float with an automatic alarm should be installed on each kettle so that the compounder will not overflow the kettle if the air supply should ever fail.

For suggestions as to mechanical details and help in the actual construction of the apparatus, the author is indebted to Ralph B. Pierce, Refineries Manager, and to the mechanical department of the Arkansas Fuel Oil Co.



* Present address, Manapla, Occ. Negros, P.I.

Machinery, Materials and Products

Mechanical Floc Former

IN THE TREATMENT of water for the removal of color and turbidity, customary practice is to add a coagulant which forms a flocculant precipitate which, in settling out, removes suspended and colloidal material by absorption and entanglement. Whereas formerly it was usual to allow this precipitate to settle without intentional agitation, it is now known that properly controlled mechanical agitation during the floc forming stage assists the formation of a dense, rapidly settling precipitate by bringing the microscopic crystals into contact so that they coalesce. To accomplish such agitation the Permutit Co., 330 West 42nd St., New York, N. Y., has recently announced a new floc former employing a novel type of agitator known as a rolling mixer. Superficially similar in appearance to a gate agitator, the rolling type differs in that the gate elements are set at varying angles with respect to their paths of rotation so to move the water uniformly across a diagonal of the tank in eddies.

Treating chemicals are first added to the water which is subjected to high speed agitation in a separate agitator until mixing is complete. Before the forming floc can be broken down by this mixing, however, the water passes to the floc former where it is subjected to the slow speed "rolling" mixing for 20 to 60 minutes before settling.

In smaller installations the high speed agitator, floc former and settling tank

can be combined in a single piece of equipment. A combination of high speed mixer and rolling mixer can be used in conjunction with a separate settling tank in intermediate sized installations, while for still greater capacity a single high speed mixer in series with a number of rolling mixers is provided to feed a large settling basin.

Under-Driven Dissolver

AN ADDITION to its line of dissolvers, designed for use where low available headroom makes necessary the lowest possible over-all height of the machine, has been announced by the Patterson Foundry & Machine Co., East Liverpool, Ohio. Although used in the rayon industry for dissolving xanthate, the machine is said also to be suitable for the dissolution of other cellulose derivatives, as well as many other materials. The dissolver is built in both plain and jacketed types, in a number of sizes. A compact type of undergearing is employed.

Oil Seal

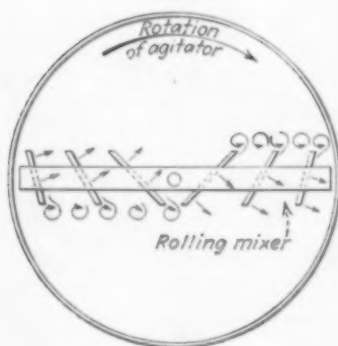
A NEW patented oil seal which is split to facilitate installation without dismantling the machine has been developed and introduced by the Garlock Packing Co., Palmyra, N. Y., and given the name of "Split-Klozure". This device is a cut-open composition sealing element or packing

ring molded into a cross-sectional shape resembling a modified V, to which a finger-type spring is bonded under pressure. The sealing element and spring are handled and applied as a single unit. The material used is dense, non-porous and grainless, and is stated not to absorb oil and so lose its inherent resiliency. These new rings are available for shafts from 3 to 52 in. in diameter.

Submersible Pump

AFTER EIGHT YEARS of successful operation under widely varying conditions, the Byron Jackson Co., Los Angeles, Calif., has introduced a new submersible deep-well turbine pump in which the motor is below, not above, the pump proper. The long, small-diameter motor is submerged at all times in the well water, but no electrical parts or motor bearings come in contact with the water, as they are inclosed in an oil-filled case with a mercury seal at the point where the shaft passes through at the top. The pump and motor form a compact unit supported by the discharge pipe. A high dielectric oil is circulated through

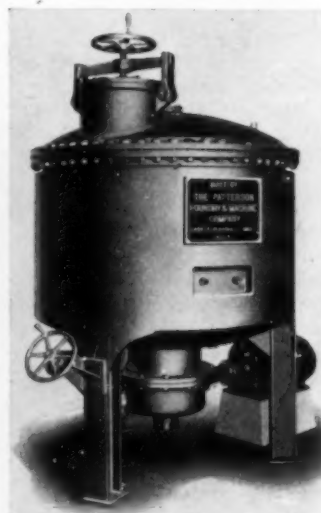
Diagram of rolling mixer shown in plan



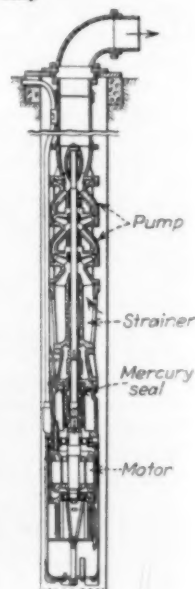
New Split-Klozure

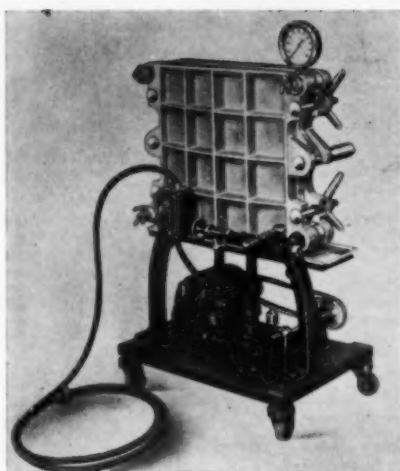


New underground dissolver

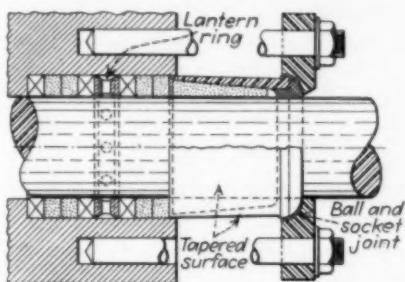


Cross-section of submersible deep well pump





Seitz single disk Junior filter



Cross-section of packing gland

the motor windings at all times. Motor oil and well water are completely separated, by a cylindrical sleeve placed around the motor shaft with one end submerged in mercury.

Junior Clarifying Filter

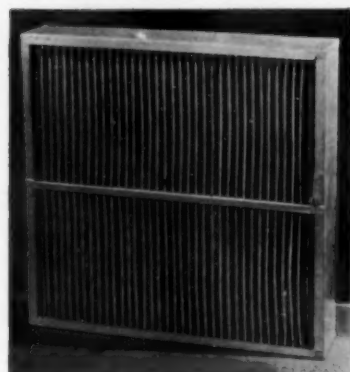
DESIGNATED as No. 40-1, a new single disk Junior filter has been introduced by American Seitz Filter Corp., 480 Lexington Ave., New York, N. Y. Employing a 16x16-in. filter sheet equivalent to about twice the area of a round 12-in. sheet, the filter is said to have a clarifying capacity up to 100 gal. per hour. Without making any changes or purchasing additional parts, additional filter screens can be added so that the filter can be expanded to a total of seven sheets. If two stage filtration is desired, a special type of bypass plate is available. Filter sheets are divided into two sections so that the filtrate from the first section flows into the second section where it is filtered again. Filters are supplied either with a supporting stand, including pump and motor, or without these parts, for mounting directly on a wall.

Self-Aligning Gland

CRANE PACKING CO., 1800 Cuyler Ave., Chicago, Ill., is offering a new type conical, self-aligning packing gland for ammonia, air and gas compressors, reciprocating pumps and engines. The gland cup has a conical interior, is made from



Style 409 Absco stair tread



Wire-Klad fin-type air filter

nickel steel and bearing bronze, and is packed with split packing inserts molded to fit. The effect of the taper is to force the packing around the rod with each stroke of the piston. A ball-and-socket joint between gland and follower compensate for "float." The use of split packing is said to permit repacking of the gland in a few minutes.

Non-Skid Stair Treads

AMERICAN BRAKE SHOE & FOUNDRY CO., 230 Park Ave., New York, N. Y., is manufacturing an improved type of non-slip safety metal, said to be highly resistant to rust and acid corrosion, which is marketed under the trade name of non-slip Absco metal. This material is being used for stair treads, ramps, industrial floors and similar purposes. In manufacture, electric furnace abrasive grains are applied to cast iron, bronze, aluminum or nickel silver by a special process of casting. The grains are deeply bonded into the metal, forming what is said to be a virtually indestructible bond.

Reinforced Air Filter

WIRE-KLAD is the name of a new low-cost, flame-arresting, dry type air filter for air conditioning recently put on the market by the Staynew Filter Corp., Rochester, N. Y. The filter is of fin construction, affording a large filtering area in relatively small space. The filtering medium is reinforced by a wire mesh so that it is stated that the filter can be cleaned repeatedly by either high-pressure air or vacuum. Several kinds of filter media are available, including cotton and wool felt-like materials. Four standard sizes and three standard depths are made.

Gas Cleaner

HIGH CLEANING EFFICIENCY for compressed air, gas, steam and various industrial vapors is claimed for a compact new gas cleaning unit, weighing only 15½ lb., recently announced by the Textite Corp., 2110 Roscoe St., Chicago, Ill. The Hager separator contains three cleaning stages in each of which vanes cause fluid to whirl rapidly, after which the flow is caught by other vanes curved in the opposite direction, throwing out moisture and dirt by centrifugal action during the reversal. Separated materials are dropped into a collection chamber. Corrosion resisting materials are used in these separators which are available in sizes up to ¾-in. pipe size.

Equipment Briefs

WHAT IS SAID to be a new principle in mercury switch operation is found in the 1 hp. capacity mercury plunger switch or relay recently announced by the H-B Electric Co., 2518 North Broad St., Philadelphia, Pa. A glass tube set vertically or within an angle of 45 deg. of the vertical contains mercury on which a magnetic plunger floats. One lead wire of the switch connects with this mercury. Above the normal mercury surface is a ceramic cup containing mercury which serves as the second contact. A solenoid coil surrounding the glass tube, when energized, depresses the magnetic plunger, raises the mercury level, and causes it to make mercury-to-mercury contact with the mercury in the cup, thus completing the circuit. Breaking the solenoid circuit releases the plunger and drops the mercury so as to open the controlled circuit.

NEW ELECTRICAL DEVELOPMENTS recently announced by the Clark Controller Co., Cleveland, Ohio, include a new mill type thermal overload relay, an across-the-line automatic starter for squirrel cage motors, and a heavy duty master switch for crane service and other applications where frequent operation is necessary. The overload relay, designed for the protection of a.c. motors, employs a special thermal mechanism actuated by two heater elements. During an overload of sufficient duration, the heaters melt a special eutectic metal, thus permitting the turning of a pin and allowing the contacts to snap open. The relay may be reset manually as soon as the thermal mechanism has cooled. The new starters are of the non-reversing type, equipped with self cleaning wiping contacts, cadmium plated metal parts and molded asbestos arc shields. The master switches are equipped with roller bearings, cam contactors and silver-to-silver contacts available in from one to six points.

PARANITE-G.O.P. is the name of a new transmission belt recently perfected by the Manhattan Rubber Mfg. Division of

Raybestos-Manhattan, Inc., Passaic, N. J. The new belt contains no natural rubber, the friction compound being a recently perfected synthetic material, G.O.P. (gas and oilproof), which is used and compounded as is rubber. This material is stated to be unaffected by oil which will not cause swelling or deterioration. Regular transmission sizes are made.

CONNECTION of pipe to containers of all sorts, without the necessity of working from the inside, is possible with the

new Multi-Seal front drive pipe connector recently announced by the Multi-Seal Mfg. Co., 123 North Jefferson St., Chicago, Ill. This device is a one-piece unit which is inserted in a hole in the container and expanded into the hole by holding the body of the unit stationary with one wrench, while with another wrench a portion known as an "action nut" is screwed up. The outer end of the unit is provided with a standard pipe thread for connecting a valve, pipe or pipe fitting.

Instruments. Weston Electrical Instrument Corp., Newark, N. J.—12 pages on this company's industrial temperature gages, describing construction, ranges, types and accessories.

Materials Handling. The Fairbanks Co., 393 Lafayette St., New York City—Catalog 54—20 pages covering a wide variety of wheelbarrows and scrapers made by this company.

Materials Handling. Pressed Steel Car Co., Koppel Division, Grant Bldg., Pittsburgh, Pa.—Bulletin 71—16 pages describing this company's line of industrial railway cars and accessory equipment, covering a wide variety of cars for all purposes.

Ovens. American Machine & Foundry Co., Crawford Oven Division, 200 Shelton Ave., New Haven, Conn.—Sections 100-105—44-page catalog of loose-leaf sections on industrial ovens and dryers for finishing and other heat-treating operations with descriptions and engineering data.

Packaging. Bemis Bro. Bag Co., 601 South 4th St., St. Louis, Mo.—5-page book describing in detail this company's tape sealer method of closing open-mouthed, multi-wall bags.

Pipe and Fittings. Taylor Forge & Pipe Works, Box 485, Chicago, Ill.—Catalog 36—40 pages on this company's light-wall spiral pipe, with information on construction, properties, joints, dimensions, flanges and fittings, protection, and other data, such as friction loss; also Catalog 36-3, 84 pages on seamless forged steel nozzles; also flanges and weld fittings.

Plastics. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Descriptive Data 63-020—4-page leaflet listing standard sizes, colors and finishes of Micarta, with tabulation of physical and electrical properties and applications.

Pumps. Goulds Pumps, Inc., Seneca Falls, N. Y.—Bulletin describing this company's new line of Fig. 3390 centrifugal pumps of two-stage balanced design for heads up to 1,000 ft.

Pumps. Lawrence Machine & Pump Corp., 371 Market St., Lawrence, Mass.—Bulletin 203-2—4 pages describing this company's acid and chemical pumps with general specifications on construction, and other information.

Pumps. Morris Machine Works, Baldwinville, N. Y.—Bulletin 173—4 pages describing centrifugal slurry and sludge pumps made by this company, with description and performance information.

Reflectors. R L M Standards Institute, Inc., Room 1130, 20 North Wacker Drive, Chicago, Ill.—"Meaning of the R L M Label," a factual exposition of the principles of industrial light conditioning, with information on basic factors in industrial lighting and basic standards of efficiency, design and quality of reflectors.

Steam Generation. Green Fuel Economizer Co., Beacon, N. Y.—Bulletin 167—16-page bulletin describing this company's ringstay-type economizer for recovering waste heat from boiler flue gases for feedwater heating.

Strainers. Elliott Co., Jeannette, Pa.—Bulletin A-8—4 pages describing this company's Type K self-cleaning strainer of the automatic back-washing type.

Tenite. Tennessee Eastman Corp., Kingsport, Tenn.—Edition 1 B, Tenite Specifications—20-page book covering in detail data on physical properties involved in the selection of all Tenite formulas.

Valves. The Lünkenheimer Co., P. O. Box 360, Annex Station, Cincinnati, Ohio—List price schedule R1—24-page price list covering this company's entire line of valves, boiler mountings, lubricating devices and parts.

MANUFACTURERS' LATEST PUBLICATIONS

Air Conditioning. Carrier Corp., Syracuse, N. Y.—Publications as follows: Leaflet 46E1, 4 pages on ratings, prices, dimensions and other data on unit heaters; CR-120, 6 pages on condensing units from $\frac{1}{4}$ to 50 hp., with specifications; CR-121, 4 pages on cold diffusers in sizes from 200 to 11,000 c.f.m.

Alloys. Republic Steel Corp., Advertising Division, Cleveland, Ohio—Bulletin ADV 313—8-page folder on stainless and heat-resisting steels and other Republic products for the process industries, with specific use recommendations.

Alloys. Joseph T. Ryerson & Son, Inc., P. O. Box 8000A, Chicago, Ill.—Booklet on the applications of Allegheny stainless steels, with brief summary of these steels stocked by Ryerson.

Alloys. Rustless Iron & Steel Corp., Baltimore, Md.—60-page handbook on this company's corrosion and heat resisting stainless steels, with complete information on all types, covering physical, tensile, resistant and working properties; also tables of weights and other useful information.

Bearings. Boston Gear Works, Inc., North Quincy, Mass.—16-page booklet on Oilite precision bronze bearings, distributed by this company and produced by the Chrysler Corp.

Blast Gates. W. S. Rockwell Co., 50 Church St., New York City—Bulletin 376—8 pages with description and engineering data covering this company's blast gates.

Chemicals. Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia, Pa.—32-page book on liquid chlorine with information on properties, containers, handling, uses, chlorine compounds, analytical methods, and the handling of leaks.

Chemicals. Pfaltz & Bauer, Inc., Empire State Bldg., New York City—Leaflet describing DeHaen's Fixanal preparations for standard solutions, certified to an accuracy within two parts per 1,000.

Coils. The Trane Co., LaCrosse, Wis.—Bulletin 8-330—20 pages describing a wide variety of extended surface heating and cooling coils made by this company.

Disintegration. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1821-D—20-page catalog with descriptions and detailed engineering data covering this company's rod mills and accessories.

Enameling. Porcelain Enamel & Mfg. Co., Baltimore, Md.—Enamellers' Reference No. 2—7-page booklet discussing enamel storage.

Electrical Equipment. General Electric Co., Schenectady, N. Y.—GEA-2954—4-page booklet on reduced-voltage, oil-immersed magnetic starters for process industries use, with information on construction details, dimensions and rating, and overload relay data.

Engines. Ingersoll-Rand Co., 11 Broadway, New York City—Bulletin 10,011—Describes this company's Type PVG gas engines, available in 4, 6 and 8 cylinder models in sizes to 370 hp.

Equipment. E. B. Badger & Sons Co., 75 Pitts St., Boston, Mass.—8-page booklet describing this company's services in the construction of plants and equipment in such fields as petroleum refining, solvents, alcohols, wood and coke chemicals.

Equipment. Homogeneous Equipment Co., Downingtown, Pa.—4-page bulletin illustrating and briefly describing types of homogeneous linings and sprayed coatings produced by this company.

Equipment. Swenson Evaporator Co., Harvey, Ill.—12-page booklet covering this company's complete line of evaporators, crystallizers and filters, with typical flowsheets.

Fans. National Association of Fan Manufacturers, 5-208 General Motors Bldg., Detroit, Mich.—Bulletin 103—Third edition of the Association's "Standard Test Code for Centrifugal and Axial Fans," with information and definitions on methods of testing and measuring. Price 25 cents.

Filters. Oliver United Filters, Inc., 33 West 42d St., New York City—16-page book describing the Oliver-Campbell cachaça filter for use in the sugar industry.

Floors. Acme Steel, 2840 Archer Ave., Chicago, Ill.—Form AD3—12-page booklet describing this company's method of armoring concrete floors for increased safety and for protection against heavy service.

Heat Exchangers. American District Steam Co., North Tonawanda, N. Y.—Bulletin 35-76 page 7—Leaflet describing an economizer for transferring the heat in condensate to process water.

Instruments. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio—Bulletin 102-B—32-pages describing the application of this company's steam flow-air flow automatic readjustment type of air-operated combustion control.

Instruments. The Foxboro Co., Foxboro, Mass.—Bulletin 170-1—38-page bulletin on flow control with description of instruments and numerous typical examples.

Instruments. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.—Catalog E-00A—8-page booklet describing this company's thermionic amplifier for pH and other potential measurements in high resistant circuits.

Instruments. C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y.—Catalog 1060D—64 pages on this company's indicating, recording and controlling instruments for temperature and pressure, with descriptions, specifications and information on latest developments.

Chemical Engineering NEWS

Rubber Symposium Arranged For A.S.M.E. Meeting

A symposium on Rubber will be sponsored by the Committee on Rubber and Plastics at the Fall Meeting of the American Society of Mechanical Engineers, to be held at the Providence-Biltmore Hotel, Providence, R.I., Oct. 5-7.

The papers to be presented at this meeting will particularly emphasize mechanical problems in the production and use of rubber. These include "The Engineering History of Rubber," by Dr. W. C. Geer, Ithaca, N. Y.; "Synthetic Substances with Rubberlike Properties," by E. R. Bridgwater, E. I. du Pont de Nemours & Co., Wilmington, Del.

"Problems in the Production of Rubber," by E. G. Kimmich, Goodyear Tire and Rubber Co., Akron, O.; and "The Mechanical Characteristics of Rubber," by F. L. Haushalter, B. F. Goodrich Co., Akron, O.

Safety Council Will Meet In Chicago

The Silver Jubilee Safety Congress and Exposition of the National Safety Council has been scheduled for Oct. 10-14, with the Stevens Hotel, Chicago as headquarters. The Chemical Section, of which H. L. Miner of E. I. du Pont de Nemours & Co., Wilmington, is general chairman will assemble at luncheon on Oct. 11 and will hear an address on "Personal Protective Equipment for Chemical Plant Employees," by William F. Yant, director of research and development, Mine Safety Appliances Co., Pittsburgh.

In the afternoon, Chairman Miner will deliver his message to the Section. This will be followed by a talk on "The Chemical Maintenance Man's Problem in the Prevention of Personal Injuries," by Stanley Warzala, The Calco Chemical Co., Inc., Bound Brook, N. J. R. C. Stratton, The Travelers Insurance Co., Hartford, will follow with a "Report of Statistics and Safety Contest Committee." The session will close with the election of officers for 1938-39.

On the afternoon of Oct. 13, R. O. Keefer, Aluminum Co. of America, Pittsburgh, will talk on "Purchasing for Safety." Three twenty-minute talks on "The Goggle Problem" will be divided as follows: "Goggles for Protection Against

Corrosive Liquid Splashes," by P. V. Tilden, E. I. du Pont de Nemours & Co., Wilmington; "Goggles for Protection Against Radiant Energy," by G. E. Sanford, General Electric Co., Schenectady; and "Goggles for Protection Against Flying Missiles," by Harry Guilbert, The Pullman Co., Chicago.

Chemical Exhibits Planned For Golden Gate Fair

With about 20 acres of Treasure Island, in San Francisco Bay, reserved for exhibitors, the Golden Gate International Exposition, which will open early in 1939, promises to have a stimulating effect upon industrial activity in the Pacific Coast area.

As an additional means for travel to and from the Exposition, it has just been announced that China Clippers will operate from Treasure Island during the period of the Exposition—Feb. 18 to Dec. 2.

Many of the leading chemical companies will participate as exhibitors. Among the companies which already have arranged for representation are: Ciba Pharmaceutical Products, Inc., Dow Chemical Co., E. I. du Pont de Nemours & Co., W. P. Fuller & Co., General Elec-

tric Co., Petroleum Exhibitors, Inc., Johns-Manville Sales Corp., Libby-Owens-Ford Glass Co., Eli Lilly & Co., The Okonite Co., Owens-Illinois Pacific Coast Co., Pacific Coast Gas Ass'n., Pacific Gas & Electric Co., The Paraffine Co.'s, Inc., Pasteur Institute, Pittsburgh Plate Glass Co., Schering Corp., United States Steel Corp., Viticultural Industries, Inc., Western Sugar Refinery, Westinghouse Electric & Mfg. Co., Winthrop Chemical Co. and The Dorr Co.

Transactions of World Power Conference Available

Orders are now being received for Transactions of the Third World Power Conference and the Second Congress on Large Dams which were held concurrently in Washington, Sept. 7-12, 1936. The Transactions will be printed at the U. S. Government Printing Office and orders should be sent to the American National Committee or to the National Committee of any of the participating countries. While exact prices cannot be determined until after publication, estimates indicate that the charge for the Conference Transactions will not exceed \$22 per set of 10 volumes.

View of Treasure Island—in foreground, San Francisco-Oakland Bridge—on left, Alcatraz Island



ECONOMIC fundamentals will be faced by the National Economic Committee if they pay deserved attention to the Berle memorandum which was prepared at their request. That document represents as sweeping and critical a restatement of policy with respect to monopoly and business regulation as anything that has appeared in many years. Because it comes from one of the original brain-trust liberals, it is all the more important. And its words of caution are much more likely to be observed by the members of Congress and departmental executives who constitute this so-called anti-monopoly committee.

This report by Berle was not written in his capacity as Assistant Secretary of State. It is, rather, a resume of the considered opinion of one who has been associated with President Roosevelt from the political campaign of 1932. The realistic approach which it gives is not the first evidence that Mr. Berle, although a liberal, is far from a radical.

The Berle interpretation of business organization and practices, rather than the narrow theme of monopoly, would have us test any organization of business to find out whether it actually works. The test might be that it gives an adequate supply of goods with a maximum opportunity for employment with due regard for the liberty and self-development of the individual worker.

Past investigations have proceeded from preconceptions and unwarranted assumptions, among which those now needing to be avoided are: The idea that a small business is necessarily competitive or necessarily humane. Competition among small units is just as likely as not to produce, through sheer economic pressure, conditions that are not only undesirable, but also cruel.

Size is not a measure of efficiency or inefficiency, generally speaking. Moreover there is no clear definition of what is "efficiency." Probably for any particular technical or mechanical purpose there is an optimum of size. But this size varies with both industry and circumstances, may change from time to time in any given industry.

Large industry may raise the standard of living, but it does not necessarily do so. Often there is no clear distinction between what people want and what they need. This roots in the difficulty of defining what is a "good life."

In effect, Mr. Berle would have the proposed investigation search for an organization of business that actually works, in that it supplies the existing and developing wants of the people with an adequate quantity of goods. The distribution system must make possible the satisfaction of the greatest number of persons and must give the maximum number of people a chance to satisfy all their wants through proper contribution to the system.

The successful system must not inter-

NEWS FROM WASHINGTON



Washington News Bureau
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Paul Wooton, Chief

fere unduly, either actually or potentially, with the liberty of the individual. The system controls must release more individuality than they suppress.

There is no reason to believe that a single system or a single size standard or a single set of practices can usefully be applied to varied industries.

There is no merit in attacking existing ways without realization that there are probably real reasons for present practice. There may be good reason back of seemingly unfortunate social procedure. Interruption of present system has no advantage unless an equivalent or better machinery is provided as a substitute.

Drug and Cosmetic Plans

There will be no gap in the administration of food and drug law rules during the interval before the law of 1938 takes full effect, June 25, 1939. The Food and Drug Administration, which is the official agency of the Secretary of Agriculture for enforcement, has announced that all regulations, standards, and practices which prevailed under the old statute will continue in force.

The Chief of the Administration, Dr. W. G. Campbell, has announced certain important changes in personnel to take effect immediately. A new Food Standards Committee has been named, to be made up of four state food law officials and two members of the Food and Drug Administration, with Joseph Callaway, Jr., as secretary and technical assistant to the Chief. This committee will consider available information on proposed standards of identity and quality, and serve as technical advisory agency to the Chief of the Administration and the Secretary of Agriculture.

Because of the new responsibility with respect to cosmetics, a major division of the Administration is being set up to handle these matters. Roy S. Pruitt has

been transferred from New Orleans as technical chief. He will be assisted by Dan Dahle in the development of methods of analysis, identification, and testing. For more efficient administration of the drug division work, the ranking members of that group have been given enlarged responsibilities, but no other major changes in personnel are expected.

Wage-Hour Rulings

Attention to the labor problems of the chemical industries by Wage-Hour Administrator Elmer Andrews does not seem likely to be imminent. That official is pressing on problems of the more difficult industries, such as textiles and tobacco. Great point is made by newspaper comment of the fact that Donald Nelson, vice-president of Sears Roebuck, who is chairman of the industry committee for textiles, is a technical man, a chemist by training and experience. Realistic factual approach is expected from him and evidently desired by Administrator Andrews.

Most frequently mentioned of the chemical industry group as needing attention soon is the fertilizer business. It is expected that two important problems of that industry will require attention before the next period of greater seasonal activity in the Spring. These problems are low-wage part-time common laborers, mostly colored; and the question as to whether this industry can rightly be defined under the law as "seasonal." If it is so defined by an industry committee with the approval of the Administrator, then it will be exempt during its season from the limits on maximum hours of work per week without overtime pay. Naturally the fertilizer industry very much hopes for that definition and exemption. Few, if any, other divisions of chemical industry have any chance of securing that classification.

N.L.R.B. To Be Revised

Washington is puzzled by conflicting evidence with respect to the proposed changes in the National Labor Relations Act under which N.L.R.B. functions. The President announced after conference with A.F. of L. president Green that he agreed with that gentleman on the need for clarification of the law. But almost the same day the President announced the reappointment as a member of the Board of Donald Wakefield Smith for another five-year term despite the open and bitter objection of A.F. of L.

Business spokesmen in Washington are insisting that the Wagner law provides an *ex parte* judge. They insist that justice cannot be expected from any Board which must function under the act as it now stands. And still more bitter (and still more justified) objection is made to the obvious partisanship of Board executives, not only for labor, but more particularly for C.I.O. organization of labor as against all other unions.

NEW REICH RESEARCH COUNCIL AIDS IN DEVELOPING GERMAN PRODUCTS

From Our German Correspondent

GERMAN chemical companies, cooperating with government agencies and scientific institutes are carrying on a greatly intensified research program under the second "Four-Year Plan." The newly formed Reich Research Council (*Chem. & Met.*, July 1937) is supervising research all over the Reich and is outlining the problems which are considered of greatest national importance. Although this means regimentation, the methods and actual experiments are carried out at the individual initiative of institutes and factories, which are constantly increasing appropriations for research and are enlarging scientific staffs. Chief emphasis is placed on developing synthetics, conserving materials, and utilizing waste and byproducts.

That this new research drive has been fruitful is indicated by the fact that during the past year enough technical progress was made in developing new processes for synthetic products, including plastics, textile fibers, rubber, fats, light metal alloys, and motor fuels, that a number of them are now applied in large scale commercial production. Whereas some of these processes would not be profitable at the outset in a free economic system, German manufacturers are safeguarded with guaranteed prices, a fair return on their investment, and government subsidy, direct and indirect, when needed; and some of the new products are now reaching a stage where they are even able to compete on world markets.

Last year three large new synthetic gasoline plants and ten smaller ones were completed, enabling the Reich to supply over one half its light motor fuel requirements domestically. Production of synthetic rubber "Buna" has expanded, and in addition to the enlarged plants of I. G. Farben, the Continental Gummi Werke A. G., Hanover, is constructing new units to make diversified rubber products from "Buna." Whereas the "Buna" output has been used heretofore chiefly for army and government purposes, it is now becoming more generally available. Because of its chemical and heat resisting qualities and elasticity, new uses are being found every day for it in the chemical industry in building equipment and apparatus, and in spite of its higher cost, it bids fair in time to replace the natural products for automobile tires in Germany at least.

With the completion last year of the Witten plant in the Ruhr and the present construction of two similar plants, the

production of synthetic fatty acids by the oxidation of paraffine hydrocarbons is approaching a commercial scale. By the end of this year these three plants will be able to supply one quarter of the soap industry's requirements of fatty acids. In the soap industry, domestic substitutes for fats are obtained through extraction of oil from grape kernels, liquid rosin, whale oil, and the so-called "sulphite" soap made from cellulose waste liquor. The liquor occurs in large quantities as a byproduct of the woodpulp industry, and is being investigated for possible exploitation as a source of solvents, tanning materials, and a number of other products in addition to soap. Fat-containing soaps are also being replaced by textile detergents for laundry use, and the first purely synthetic and entirely fatless textile detergent is being marketed under the name of "Igepal," which is an improvement over the older "Igepon" products.

Production capacity for synthetic cellulose fibers has been expanded tremendously to bring Germany into first place in world "cellwool" (staple fiber) and third in rayon output, and this increased production has led to a proportionately larger consumption of requisite chemicals, including carbon bisulphide, alkalis, and sulphuric acid. Enough progress has been made in the shifting of the base of cellulose production to beech wood, which is readily available domestically, that from next year on cellwool and rayon are expected to be made only from beech wood, leaving pine wood supplies for the paper producing industry.

By shifting the raw material base for synthetic carbon black from naphthalene to the cheaper and more abundant anthracene residue, the cost of producing this former import item has been reduced considerably, and at the same time a supply of naphthalene has been released for other uses, especially for the manufacture of alkyd resins, which are being used increasingly for varnish purposes. Synthetic resin production has made possibly the most rapid progress of the new chemical processes. About 85 per cent of the new synthetic resin materials are phenolic condensation products, but other types are gaining ground with new uses being found for them, among the latest being to replace tin-lead in the manufacture of printing type, and in the manufacture of plastic seals instead of lead seals for locking freight cars, meters, packages, etc. The output of pyroxylin plastics last year equaled that of 1929,

and this in turn advanced the production of synthetic camphor needed in their manufacture.

Progress has also been made in the commercial production of sulphur according to the "alkacid" and "catasulf" processes, the latter for producing ammonium sulphate by utilizing sulphur contained in coke oven gases. With increased coke production, the output of the byproduct tar grew, but a new market outlet for coal-tar pitch was found in manufacturing electrodes in place of petroleum coke used by the aluminum industry.

A transparent material for handling hydrofluoric acid is being marketed in Germany as "Trolitul," a polymerization product of polystyrol. The new material, which is as transparent as glass but is not attacked by hydrofluoric acid, is available in the form of sheets, rods, or pipes and can be drilled, sawed, and filed, or joined with other pieces or materials. When placed in boiling water the material becomes pliable and by applying a solution of benzol to the ends, two pieces can be easily joined together.

A process patented by the Rheinische Maschinen- und Apparatebau Anstalt Peter Dinkels & Sohn, G.m.b.H., Mainz, consists of a new method of lining containers and apparatus with rolled silver, platinum, nickel, or other metals. The coating is claimed not to have the disadvantages of the porousness of the older galvanic or electrolytic processes. The precious metals can be applied in any thicknesses from 1/2 mm. on up, and are formed separately before they are joined as a homogeneous mass with the other material, giving the apparatus the desired chemical or thermal resisting qualities while retaining the mechanical advantages.

Four German Chemical Firms Observe 75th Anniversary

In Germany 1863 seems to have been a favorable year for the German chemical industry, and four of the original eight plants of the I.G. Farben founder group are celebrating their diamond jubilee this year. Possibly most famous is the former firm of Friedrich Bayer & Co., of Elberfeld, one of the world's leading pharmaceutical concerns. Recently the I.G. plant at Frankfurt-Hochst observed its 75th anniversary. Formerly Meister Lucius & Bruning, this factory attained world fame before the war as the leading manufacturer of aniline dyes, and its present program includes a wide variety of products.

In August the firm of Kalle & Co. A.G., of Biebrich-Wiesbaden, which specializes in cellulose derivatives and which contributed the invention of cellophane, also observed its 75th anniversary with a celebration attended by government officials and leaders of the German chemical industry. September will also see the 75th birthday of the I.G. Griesheim Chemische Fabrik, which specializes in intermediate chemical products.

PERSONALITIES

IN THE WEST AND SOUTHWEST
AS CAUGHT BY THE EDITOR'S CAMERA



(1) SMITH D. "SPARKY" TURNER cleaning up his desk in the technical division, Humble Oil & Refining Co. at Baytown, Texas, prior to moving into a new job with Standard Oil (N. J.), in Rockefeller Center, New York City. (2) FRED C. BOWMAN, director of research for A. R. Maas Chemical Co. in Los Angeles has a Hollywood smile. (3) WILLIAM "BILL" BURGESS runs the Trail sulphur plant described elsewhere in this issue. (4) The staff of the chemical engineering department at Louisiana State University sizes up the situation. (l. to r., ASSISTANT PROFESSOR KELLER, ASSISTANT PROFESSOR COATES, PROF. PAUL M. HORTON) (5) MAJOR S. E. HUTTON, in charge of information at Grand Coulee Dam, is a well known authority on portland cement manufacture and use. (6) WALTER A. SCHMIDT, president of the Western Precipitation Co. caught smiling in his own garden in Los Angeles. (7) J. L. JORDAN, mining manager and (8) ALFRED P. HARTLAPP, plant superintendent, keep things run-

ning for Myles Salt Co. on Weeks Island, La. (9) G. F. COOPE, president of the Potash Co. of America at Carlsbad, N. M., got his first chemical engineering experience in the nitrate industry in Chile. (10) HARRY BARNARD, superintendent of the big plant at Anaconda, Mont., is expressing his views on the political aspects of western phosphates. (11) Not a big game hunter but General Superintendent H. J. BRODERSON of the Pan American refinery at Texas City checking up on plant operations. (12) PROF. CHARLES S. WILLIAMSON, JR., proudly takes his stand in his chemical engineering laboratory at Tulane. (13) PERRY J. SWEENEY, general manager at Pan American's "engineer's dream of an oil refinery," sits back in his air-conditioned office at Texas City.

♦ JOSEPH CALLAWAY, JR., chief chemist of the Eastern Food and Drug Inspection District with headquarters at New York, is being transferred to Washington as senior chemist to serve as technical assistant and secretary of the reorganized Food Standards Committee.

♦ W. N. DAVIS has been appointed assistant director of research and development of the Standard Oil Co. of California and is now located at the San Francisco office. He has been succeeded at the company's Richmond, Calif., refinery by Dr. Norman Gay.

♦ KARL FALK, who until recently has served as *Chem. & Met.*'s Berlin correspondent, is now professor of economics at Fresno State College, Fresno, Calif.

♦ J. V. N. DORR has been elected by the American Section of the Society of Chemical Industry to receive the Chemical Industry Medal for 1938. The medal, which is an annual award "for important contributions to the application of chemistry in industry," will be presented to Mr. Dorr at a meeting of the Society in November.

♦ HORACE T. HERRICK, who has been with the Bureau of Chemistry and Soils for the past 12 years, has been appointed an assistant chief of the bureau and will assume responsibility for the general direction and coordination of the chemical and chemical engineering investigation of the four regional research laboratories authorized by A.A.A. to develop new technical uses for farm products.



Harry A. Curtis

♦ HARRY A. CURTIS has resigned as chief chemical engineer of the Tennessee Valley Authority, effective October 1, to become dean of the college of engineering at University of Missouri, Columbia, Mo. He will continue to render part-time service to the Authority on a consulting basis.

♦ O. E. HUGHES, formerly of the U. S. Department of Agriculture's Bureau of Plant Industry Station at Orlando, Fla., is now in the research department of the Michigan Alkali Co. at Wyandotte, Mich. Dr. Hughes is assisting in the development of the company's new calcium carbonate process.

♦ LESTER G. METCALF, Union Oil Company's manager of refineries for the past eight years, has been appointed director of manufacturing, succeeding R. E. Haylett who died June 13. Mr. Metcalf is located in the company's Los Angeles office.

♦ WILLIAM C. MCINDOE is now on the research staff of Industrial West, Inc., at San Francisco. Mr. McIndoe has been associated with the U. S. Army Engineer Corps at Portland, Ore., as industrial chemist engaged in studies looking to the possible uses of Bonneville power.

♦ RAYMOND M. MILLER, who has been

acting as metallurgical consultant to the U. S. Army Engineer Corps at Portland, Ore., is now in charge of research on resources and industry of the eleven western states for Industrial West, Inc., at San Francisco.

♦ ROY S. PRUITT now chief chemist of the New Orleans Food and Drug Inspection Station, is being transferred to Washington to handle administrative details of the new cosmetic section of the Federal Food, Drug and Cosmetic Act.

♦ JOSEPH K. ROBERTS, assistant to Bruce K. Brown, general manager of research and development of the Standard Oil Co. of Indiana, has been promoted to the position of director of research. Dr. F. W. Sullivan, Jr., present director of research at Whiting, has resigned effective October 15.

♦ LEROY M. SHANEMAN has been assigned to a sales position in the St. Louis offices of the Pennsylvania Salt Mfg. Co. Before joining the company in March, 1935, Mr. Shaneman was in the control laboratory of the Pulp Division of the Weyerhaeuser Timber Co.

♦ ROLAND B. SNOW has been appointed a research engineer at Battelle Memorial Institute at Columbus, Ohio, and will work on ceramics problems. For the past two years he has been petrographer on the research staff of Carnegie-Illinois Steel Corp., South Chicago, Ill.

♦ RICHARD S. SHUTT has begun his new duties as supervisor of chemical research at Battelle Memorial Institute, Columbus, Ohio. Previously Dr. Shutt held a research position with American Cyanamid & Chemical Co. and before that was associated with Sherwin-Williams Co. and with E. I. du Pont de Nemours & Co.

♦ SMITH D. TURNER has resigned as head of technical service at the Humble Oil Co., Baytown, Tex., to accept a position with the Standard Oil Co. (N. J.), in its executive offices at 30 Rockefeller Plaza, New York City. Successor to Mr. Turner at Baytown is W. F. White, who came to Humble in 1928.

OBITUARY

♦ HARALD AHLQVIST, consulting engineer specializing in the alkali industry, died September 6 in Kingston, Jamaica, as the result of a heart attack. Mr. Ahlqvist, who was 62, had been in charge of design and construction for the Solvay Process Co. for 20 years prior to 1922. Since then he has served as consultant to alkali enterprises in many parts of the world.

♦ VINCENT W. ALLEN, assistant works manager of the Bridgeport Brass Co., died August 25 at Waterbury, Conn., age 49. Mr. Allen had been associated with the brass industry for 28 years.

♦ FRANK M. BAUER, of the firm of Pfaltz & Bauer, Inc., importers of chemicals and chemical apparatus, died July 20 at his home at Rockaway Park, L. I.

♦ RICHARD LEE KRAMER, technical investigator, development department, E. I. du Pont de Nemours & Co., died suddenly from a heart attack August 20 at his home in Wilmington, Del. He had been associated with the du Pont company since 1920, first as research chemist, then as a company representative in the London office. In 1933 he was returned to Wilmington as technical investigator.

♦ GEORGE E. MOORE, for the past 36 years superintendent and manager of the J. B. Ford Co., Wyandotte, Mich., died August 7 following an illness of several months.

♦ JOHN F. MOORE, a senior chemist on the staff of the United Chemical Co., Lynn, Mass., died suddenly on August 24 from coronary thrombosis, age 67.

♦ GEORGE R. RAYNER, executive vice-president of the Carborundum Co. and prominent industrial leader of Niagara Falls, died at his home in Lewiston Heights on August 15 after an extended illness.

♦ HERBERT MYCATT WILCOX, manager of the new products division, Westinghouse Electric & Mfg. Co., died suddenly from heart disease on July 28 while in New York on business.

O C A L E N D A R

OCT. 12-15, ELECTROCHEMICAL SOCIETY, Hotel Seneca, Rochester, N. Y.

OCT. 21-22, ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT, annual meeting, Engineering Societies Building, New York, N. Y.

NOV. 9-11, AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, annual meeting, Benjamin Franklin Hotel, Philadelphia, Pa.

DEC. 5-10, THIRTEENTH NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING, Grand Central Palace, New York City.

APRIL 16-21, 1939, AMERICAN CERAMIC SOCIETY, Hotel Stevens, Chicago, Ill.

MAY, 1939, AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Akron, O.

Chemical ECONOMICS and MARKETS

DISTRIBUTION OF CHEMICALS CONTINUED ON RISING SCALE LAST MONTH

THE improvement in demand for chemicals which began in the latter part of June was broadened in July and continued on an upward line throughout August. From data now at hand, *Chem. & Met.*'s newly devised index for consumption of chemicals will exceed 109 for August as compared with 104.89 for July and 92.92 for June. The increase in industrial activity has spread to the majority of the large consuming lines. Seasonal influences have brought some recession in the call for fertilizer materials but August brought an uplift in some branches of the glass industry which had lagged in preceding months because large inventories had to be worked off before it was deemed expedient to step up production. Pulp production, petroleum refining, steel, rayon, leather, sulphate of ammonia are industries which made a favorable showing in August. Consumption of crude rubber also showed expansion and in the textile industry there were notable gains in mill receipts of silk, wool, and rayon. Sales of paint and varnish may have declined somewhat last month but it is probable that production was higher in view of reports that the paint industry had been buying raw materials in a more active way.

Swinging into September, reports of enlarged operations in the automotive, steel, building, paint, paper, and other industries gave an optimistic prospect for consumption of chemicals and indications are that the upward swing to both production and consumption will continue for some time.

General improvement in the chemical industry is aided by the fact, that, in most cases, heavy inventories have been greatly reduced and consuming demand has appreciably increased.

F.R.B. Index Higher

The preliminary index of the Federal Reserve Board places industrial production in July at 83 which compares with 77 for June. For manufacturing industries, the index of the Board was 81 for July as compared with a revised index

of 74 for June. In each case the Board's indexes have been adjusted to make allowance for seasonal influences.

Steel manufacture generally is regarded as a dependable guide to industrial activity but the rise in steel plant operations in recent weeks is admitted to have followed producers' plans to build up stocks and as this is now thought to have been accomplished and as there is no intention to build up stocks beyond the receptive capacity of the market, it may be assumed that the future rate of manufacture will reflect the status of consumer buying.

Production of methanol in July showed a reversal inasmuch as the output of crude was higher than in the preceding month while production of synthetic was lower than in June. Production of crude methanol in July was 309,219 gal., making a total of 2,547,926 gal. for the seven months of this year compared with 3,578,253 gal. for the like period of 1937. Production of synthetic methanol in July was 1,449,607 gal. with 14,446,907 gal. for the seven months as against 15,077,546 gal. for the 1937 period.

Superphosphate production in July was somewhat less than in June, according to reports by acidulators to The National

Fertilizer Association. Usually there is a moderate rise in July, with the seasonal trend continuing upward through December. Compared with July of last year there was a decline of 30 per cent in production, making the seventh consecutive month that output was well below the corresponding month of 1937. Total production of the reporting acidulators was nearly a half million tons less in the January-July period this year than last. The decline in the North has been relatively small but production at southern plants has been a third below last year.

Foreign Trade Drops

Latest figures for foreign trade cover the month of July. The Department of Commerce figures show that both exports and imports in July were slightly lower in value than in June. This represents the usual seasonal movement, for our foreign merchandise trade generally declines in July to the low point of the year. Exports fell off 2 per cent as compared with June, while general imports were reduced by about 3 per cent.

In comparison with the corresponding month of 1937, exports were 15 per cent less in value in July, a somewhat greater decrease than was shown in June. More than half of this decline was accounted for by the lower price level; on a volume basis our foreign sales continued to make a relatively favorable showing. Import trade exhibited no further reduction as compared with a year ago; the value of general imports was 47 per cent less than in July 1937, as compared with a decrease of 49 per cent in June.

In July goods withdrawn for consumption from bonded warehouses were again larger than those that entered warehouses. As a result, the value of imports for consumption was approximately as large in July as in the preceding month, in contrast with the decline shown for general imports. The excess of withdrawals over entries of approximately 7 million dollars was the largest such figure recorded since August 1936.

Production and Consumption Data for Chemical-Consuming Industries

	July 1938	July 1937	Jan-July 1938	Jan-July 1937	Per cent of decline for 1938
Production					
Alcohol, ethyl, 1000 pr. gal.	16,370	18,254	110,591	126,825	12.0
Alcohol, denatured, 1000 wi. gal. .	6,711	6,753	44,144	48,444	8.9
Automobiles, No.	141,437	438,908	1,345,311	3,227,867	58.3
Benzol, 1000 gal.	4,769	10,762	37,200	71,683	48.1
Byproduct coke, 1000 tons	2,177	4,422	16,893	30,118	43.8
Glass containers, 1000 gr.	3,506	4,978	20,824	26,493	27.0
Plate glass, 1000 sq. ft.	5,506	15,345	30,733	121,922	74.8
Rubber reclaimed, tons.	8,273	16,241	49,674	106,749	53.5
Rosin, wood, bbl.	48,741	65,561	325,963	432,765	24.7
Turpentine, wood, bbl.	7,273	10,022	50,503	67,240	24.9
Consumption					
Cotton, 1000 bales.	450	583	3,106	4,774	34.9
Silk, bales.	32,593	31,399	222,012	265,637	16.4
Wool, 1000 lb.	27,742	28,412	125,647	242,031	48.1
Explosives, 1000 lb.	23,136	27,291	172,232	229,465	24.9
Rubber, tons.	32,209	43,650	203,553	354,142	42.5

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WITHDRAWALS OF CHEMICALS GAIN IN VOLUME SINCE TURN OF THE MONTH

CALL for deliveries of chemicals against existing contracts is reported to have involved larger amounts for September delivery. It also is reported that demand is well divided among the different chemicals. Some of the coal-tar chemicals are working into a firmer position as a result of the larger amounts moved in recent weeks. Soda ash is finding a better market especially in the glass trade where larger outputs are currently reported for all branches with the exception of containers. Rayon producers increased takings of caustic soda in August and promise to absorb still larger amounts in the present month. Steel mills are using larger amounts of sulphuric acid and the position of these three basic chemicals has taken a notable turn for the better. Fertilizer materials have been seasonably quiet but are expected to receive more attention in the near future. Paint-making materials showed a counter-seasonal trend in August and the early introduction of new automobile models should have a healthy effect on the sale of lacquers.

Prices for basic chemicals are held on a steady basis but other chemicals have responded to particular influences with price changes in both directions. Sulphate of ammonia automatically moved up in price at the beginning of the month. Some of the metal salts also were higher as a result of increased production costs.

Oils and fats developed a price weakness which was fairly inclusive, embracing both domestic and foreign products. Cottonseed oil was a leader in this movement. While consumption of this oil is holding up well, new crop is reaching the market in good quantities and this serves as a check to higher prices. While some upward revision has been made in estimates for the domestic flaxseed crop, the yield will prove sufficient for only a small part of domestic crushing requirements and

the Argentine seed market will continue as the real factor in establishing the level of prices for seed and for linseed oil.

Formaldehyde has felt the effects of lower outputs of plastics so far this year and while recent buying has been more favorable, competition promises to become keener as the result of new production.

Naval stores have been quiet with only moderate interest shown either for home use or for export. With large stocks on hand, prices have held an easy tone. Attempts are now under way to bring about some plan for crop curtailment for the coming season but in the meantime conditions are not expected to change materially.

Prices for amyl acetate also were lowered with the technical grade offered at 9½¢ per lb. in tanks and at 10½¢ per lb. in drums, carlots. The usual premiums hold good for smaller amounts. These quotations are f.o.b. destination, drums included and not returnable. Tributyl phosphate is now quoted at 42¢ per lb. in drums, and upward according to amounts involved.

A drastic reduction in price for ethyl cellulose was announced at the beginning of the month. This material is now offered in carload lots of 16,000 lb. at 45¢ a lb. under contract. Quotations for single shipments range from 48¢ a lb. for 500 lb. or over up to 55¢ a lb. for small lots. Low viscosity type ethyl cellulose is held at a premium of 3¢ a lb. above these quotations and all prices are f.o.b. cars with freight allowed to point of destination.

With a slackening in foreign demand, the Argentine casein market weakened considerably during the past six months. Exports in the first half of 1938 declined substantially, present quotations are the lowest for many years past, and current stocks on hand are abnormally high. According to a report from our commercial attaché at Buenos Aires, exports to this country in 1936 were 2,659 metric tons which dropped to 1,531 metric tons in 1937. Shipments from the Argentine to this country for the first half of 1938 amounted to only 75 metric tons.

Argentina casein stocks at the end of 1937 were officially estimated at 6,183 tons, which had increased to 7,648 tons by the end of April 1938. No more recent official estimates are available, although it is believed that the minimum carryover at the present time would be at least 8,000 tons, while some estimates are as high as 10,000 tons.

Another report to the Department of Commerce stated that production of carbon black in the Province of Alberta has been commenced. In 1934 the Alberta

Government issued a permit to the Premier Carbon Black, Limited for production of carbon black in Canada. At that time 3 wells were drilled. In June 1937 this company drilled another well and started construction of the first "hot house". The building was completed last spring and is first of a battery of sixteen houses that will be constructed on the property. There are no statistics available showing the total output of carbon black but the firm expects to obtain a yield of 1½ lb. of carbon black from a thousand cubic feet of natural gas.

A report from Frankfurt-on-Main says that following long negotiations extending over many weeks, the International Nitrogen Cartel, expiring July 1, 1938, was prolonged by the signatory members at a meeting in Paris on July 13, 1938 for a further period of 3 years. Although the exact terms of the new agreement have not been made public, it is understood that in general they are similar to those of the expiring agreement. Delay in consummating the new pact was caused by difficulties of the member-producers in reaching an agreement regarding the distribution of export quotas for the various producing countries and especially the supplying of the requirements of countries in Central and Southeastern Europe. The pact embraces European synthetic producers in Germany, England, Norway, Belgium, Czechoslovakia, Poland and Switzerland, organized as one group, on the one side, and the Chilean natural sodium nitrate industry, as one unit, on the other.

The Federal Trade Commission has issued complaints against various tile manufacturing companies. These firms are charged with making an artificial distinction between the various classes of customers in an effort to justify varying discounts from list price. In essence, F.T.C. appears to rule that the Robinson-Patman law forbids discrimination in prices between so-called wholesalers and contractor customers on the ground that this reduces the opportunity for competition which should exist between the members of the two groups.

CHEM. & MET.

Weighted Index of CHEMICAL PRICES

Base = 100 for 1935

This month	99.33
Last month	99.22
September, 1937	102.46
September, 1936	97.73

There has been no definite trend to prices for chemicals. Revisions during the month were in both directions. Solvents continue to show weakness. Sulphate of ammonia was prominent among the selections for which higher prices went into effect.

CHEM. & MET.

Weighted Index of Prices for OILS AND FATS

Base = 100 for 1935

This month	77.07
Last month	82.97
September, 1937	98.63
September, 1936	99.58

Values for oils and fats were on a descending scale with nearly all selections sharing in the decline. Crude cottonseed oil was a leader in the movement and other edible oils follow suit. Drying oils also were lower.

INDUSTRIAL CHEMICALS

	Current Price	Last Month	Last Year
Acetone, drums, lb.	\$0.051-\$0.061	\$0.051-\$0.061	\$0.06-\$0.07
Acid, acetic, 28%, bbl., cwt.	2.23-2.48	2.23-2.48	2.53-2.78
Glacial 99%, drums	8.43-8.68	8.43-8.68	8.70-8.95
U. S. P. reagent	10.25-10.50	10.25-10.50	10.75-11.00
Boric, bbl., ton.	106.00-111.00	106.00-111.00	105.00-115.00
Citric, kegs, lb.	.231-.25	.231-.25	.25-.28
Formic, bbl., ton.	.101-.11	.101-.11	.11-.111
Gallie, tech., bbl., lb.	.70-.75	.70-.75	.60-.65
Hydrofluoric 30% carb., lb.	.07-.071	.07-.071	.07-.071
Lactic, 44%, tech., light, bbl., lb.	.061-.061	.061-.061	.61-.61
Muriatic, 18", tanks, cwt.	1.05-.1.05	1.05-.1.05	1.05-.1.05
Nitric, 36", carboys, lb.	.05-.051	.05-.051	.05-.051
Oleum, tanks, wks., ton.	18.50-20.00	18.50-20.00	18.50-20.00
Oxalic, crystals, bbl., lb.	.101-.12	.101-.12	.101-.12
Phosphoric, tech., c'bye, lb.	.09-.10	.09-.10	.09-.10
Sulphuric, 60", tanks, ton.	13.00-13.00	13.00-13.00	13.00-13.00
Sulphuric, 66", tanks, ton.	16.50-16.50	16.50-16.50	16.50-16.50
Tannic, tech., bbl., lb.	.40-.45	.40-.45	.26-.30
Tartaric, powd., bbl., lb.	.271-.271	.271-.271	.241-.241
Tungstic, bbl., lb.	2.75-2.75	2.75-2.75	2.75-2.75
Alcohol, Amyl.			
From Pentane, tanks, lb.	.106-.106	.106-.106	.123-.123
Alcohol, Butyl, tanks, lb.	.081-.081	.081-.081	.081-.081
Alcohol, Ethyl, 190p't., bbl., gal.	4.581-4.581	4.581-4.581	4.14-4.14
Denatured, 190 proof.			
No. 1 special, dr., gal wks.	.29-.29	.29-.29	.34-.34
Alum, ammonia, lump, bbl., lb.	.031-.04	.031-.04	.03-.04
Potash, lump, bbl., lb.	.031-.04	.031-.04	.031-.04
Aluminum sulphate, com bags, cwt.	1.15-1.40	1.15-1.40	1.35-1.50
Iron free, bbl., cwt.	1.30-1.55	1.30-1.55	2.00-2.25
Aqua ammonia, 26", drums, lb.	.02-.03	.021-.03	.021-.03
tanks, lb.	.02-.021	.021-.021	.021-.021
Ammonia, anhydrous, cyl., lb.	.151-.151	.151-.151	.151-.16
tanks, lb.	.041-.041	.041-.041	.041-.041
Ammonium carbonate, powd, tech., casks, lb.	.08-.12	.08-.12	.08-.12
Sulphate, wks., cwt.	1.35-1.35	1.325-1.325	1.425-1.425
Amylacetate tech., tanks, lb.	.91-.91	.11-.12	.11-.111
Antimony Oxide, bbl., lb.	.111-.12	.111-.12	.151-.16
Arsenic, white, powd., bbl., lb.	.03-.031	.03-.031	.03-.031
Red, powd., kegs, lb.	.151-.16	.151-.16	.151-.16
Barium carbonate, bbl., ton.	52.50-57.50	52.50-57.50	52.50-57.50
Chloride, bbl., ton.	79.00-81.00	79.00-81.00	79.00-81.00
Nitrate, cask, lb.	.07-.08	.07-.08	.07-.08
Blanc fixe, dry, bbl., lb.	.031-.04	.031-.04	.031-.04
Bleaching powder, f. o. b., wks., drums, cwt.	2.00-2.10	2.00-2.10	2.00-2.10
Borax, gran., bags, ton.	48.00-51.00	48.00-51.00	46.00-51.00
Bromine, ca., lb.	.30-.32	.30-.32	.36-.38
Calcium acetate, bags	1.65-1.65	1.65-1.65	2.25-2.25
Arsenate, dr., lb.	.061-.07	.061-.07	.061-.07
Carbide drums, lb.	.05-.06	.05-.06	.05-.06
Chloride, fused, dr., del., ton.	21.50-24.50	21.50-24.50	20.00-33.00
flake, dr., del., ton.	23.00-25.00	23.00-25.00	22.00-35.00
Phosphate, bbl., lb.	.071-.08	.071-.08	.071-.08
Carbon bisulphide, drums, lb.	.05-.06	.05-.06	.051-.06
Tetrachloride drums, lb.	.041-.051	.051-.06	.051-.06
Chlorine, liquid, tanks, wks., lb.	2.15-2.15	2.15-2.15	2.15-2.15
Cylinders	.051-.06	.051-.06	.051-.06
Cobalt oxide, cans, lb.	1.67-1.70	1.67-1.70	1.67-1.70
Copperas, bags, f.o.b., wks., ton.	15.00-16.00	15.00-16.00	15.00-16.00
Copper carbonate, bbl., lb.	.10-.161	.09-.161	.101-.191
Sulphate, bbl., cwt.	4.25-4.50	4.25-4.40	5.15-5.40
Creosote of tartar, bbl., lb.	.221-.23	.211-.22	.181-.19
Diethylene glycol, dr., lb.	.22-.23	.22-.23	.22-.23
Epom salt, dom., tech., bbl., cwt.	1.80-2.00	1.80-2.00	1.80-2.00
Ethyl acetate, drums, lb.	.061-.061	.071-.071	.071-.071
Formaldehyde, 40%, bbl., lb.	.051-.061	.051-.061	.051-.061
Furfural, dr., lb.	.10-.171	.10-.171	.10-.171
Fuel oil, ref. drums, lb.	.121-.14	.121-.14	.16-.18
Glauber salt, bags, cwt.	.95-1.00	.95-1.00	.95-1.00
Glycerine, e.p., drums, extra, lb.	.161-.161	.161-.161	.231-.231
Lead:			
White, basic carbonate, dry casks, lb.	.061-.061	.061-.061	.08-.08
White, basic sulphate, ack., lb.	.06-.06	.06-.06	.071-.071
Red, dry, ack., lb.	.071-.071	.071-.071	.09-.09
Lead acetate, white orys., bbl., lb.	.10-.11	.10-.11	.131-.14
Lead arsenate, powd., bbl., lb.	.121-.13	.121-.13	.111-.12
Lime, chem., bulk, ton.	8.50-8.50	8.50-8.50	8.50-8.50
Litharge, powd., csk., lb.	.061-.061	.061-.061	.08-.08
Lithophone, bags, lb.	.041-.041	.041-.041	.041-.05
Magnesium carb., tech., bags, lb.	.06-.061	.06-.061	.06-.061

Current PRICES

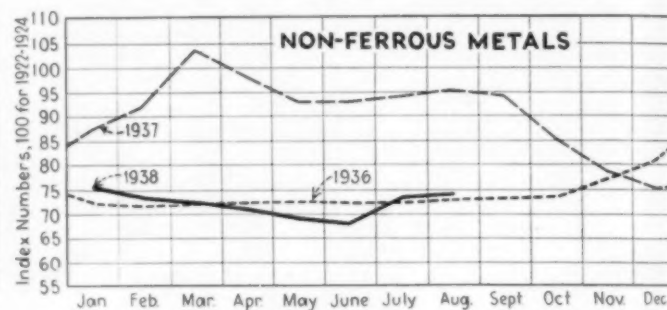
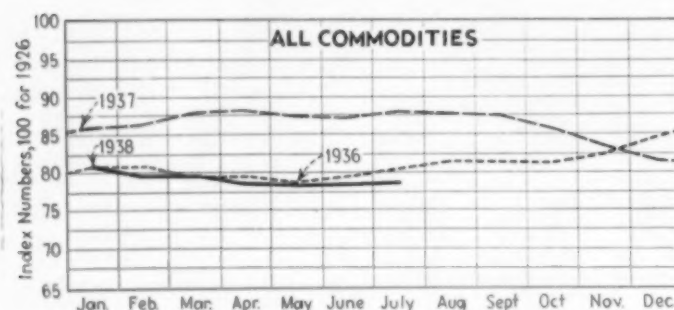
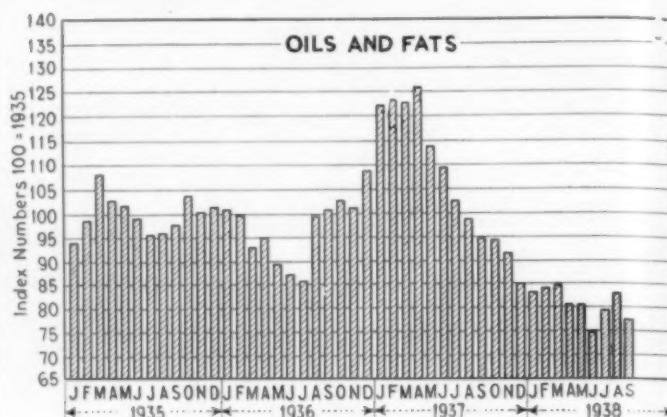
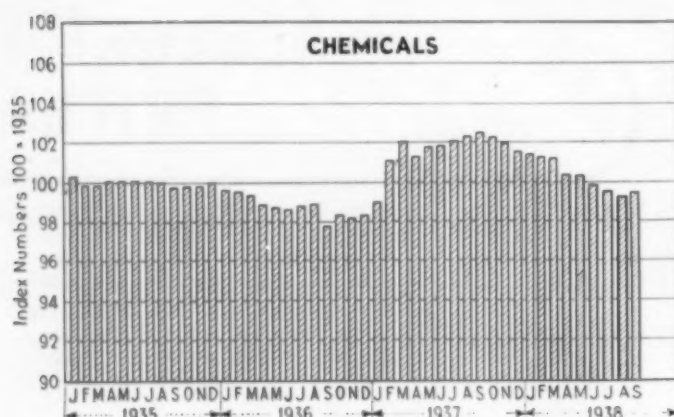
	Current Price	Last Month	Last Year
Methanol, 95%, tanks, gal.	.31-.31	.31-.31	.31-.31
97%, tanks, gal.	.32-.32	.32-.32	.32-.32
Synthetic, tanks, gal.	.33-.33	.33-.33	.33-.33
Nickel salt, double, bbl., lb.	.13-.131	.13-.131	.13-.131
Orange mineral, csk., lb.	.101-.101	.101-.101	.12-.12
Phosphorus, red, cases, lb.	.40-.42	.40-.42	.40-.42
Yellow, cases, lb.	.24-.30	.24-.30	.24-.30
Potassium bichromate, casks, lb.	.081-.09	.081-.09	.081-.09
Carbonate, 80-85%, calc. csk., lb.	.051-.06	.051-.06	.061-.07
Chlorate, powd., lb.	.091-.091	.091-.091	.091-.091
Hydroxide (caustic potash) dr., lb.	.07-.071	.07-.071	.07-.071
Muriate, 80% bags, unit.	.531-.531	.531-.531	.531-.531
Nitrate, bbl., lb.	.051-.06	.051-.06	.051-.06
Pernanganate, drums, lb.	.181-.19	.181-.19	.181-.19
Prussate, yellow, casks, lb.	.15-.16	.15-.16	.15-.16
Sal ammoniac, white, casks, lb.	.05-.051	.05-.051	.05-.051
Salsoda, bbl., cwt.	1.00-1.05	1.00-1.05	1.00-1.05
Salt cake, bulk, ton.	13.00-15.00	13.00-15.00	13.00-15.00
Soda ash, light, 58%, bags, contract, cwt.	1.23-.1.25	1.23-.1.25	1.23-.1.25
Dense, bags, cwt.	1.25-.1.25	1.25-.1.25	1.25-.1.25
Soda, caustic, 76%, solid, drums, contract, cwt.	2.60-3.00	2.60-3.00	2.60-3.00
Acetate, works, bbl., lb.	.04-.05	.04-.05	.041-.05
Bicarbonate, bbl., cwt.	1.75-2.00	1.75-2.00	1.75-2.00
Bichromate, casks, lb.	.061-.07	.061-.07	.061-.07
Bisulphate, bulk, ton.	15.00-16.00	15.00-16.00	15.00-16.00
Bisulphite, bbl., lb.	.031-.04	.031-.04	.031-.04
Chlorate, kegs, lb.	.061-.061	.061-.061	.061-.061
Chloride, tech., ton.	12.00-14.75	12.00-14.75	12.00-14.75
Cyanide, cases, dom., lb.	.14-.15	.14-.15	.161-.17
Fluoride, bbl., lb.	.071-.08	.071-.08	.071-.08
Hyposulphite, bbl., cwt.	2.40-2.50	2.40-2.50	2.40-2.50
Metasilicate, bbl., cwt.	2.20-3.20	2.20-3.20	2.15-3.15
Nitrate, bags, cwt.	1.45-.1.45	1.45-.1.45	1.425-.1.425
Nitrite, casks, lb.	.061-.07	.061-.07	.07-.08
Phosphate, dibasic, bags, lb.	1.85-.1.85	1.85-.1.85	1.70-.024
Prussiate, yel. drums, lb.	.091-.10	.091-.10	.10-.11
Silicate (40" dr.) wks., cwt.	.80-.85	.80-.85	.80-.85
Sulphide, fused, 60-62%, dr., lb.	.021-.031	.021-.031	.021-.031
Sulphite, eyra., bbl., lb.	.021-.021	.021-.021	.021-.021
Sulphur, crude at mine, bulk, ton.	18.00-18.00	18.00-18.00	18.00-18.00
Chloride, dr., lb.	.03-.04	.03-.04	.031-.04
Dioxide, cyl., lb.	.07-.08	.07-.08	.07-.071
Flour, bag, cwt.	1.60-3.00	1.60-3.00	1.60-3.00
Tin Oxide, bbl., lb.	.48-.48	.48-.48	.60-.60
Crystals, bbl., lb.	.341-.341	.35-.35	.42-.42
Zinc chloride, gran., bbl., lb.	.05-.06	.05-.06	.05-.06
Carbonate, bbl., lb.	.14-.15	.14-.15	.09-.11
Cyanide, dr., lb.	.33-.35	.33-.35	.36-.38
Dust, bbl., lb.	.061-.061	.061-.061	.091-.091
Zinc oxide, lead free, bags, lb.	.061-.061	.061-.061	.061-.061
5% lead sulphate, bags, lb.	.061-.061	.061-.061	.061-.061
Sulphate, bbl., cwt.	3.15-3.60	3.15-3.60	3.15-3.60

OILS AND FATS

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	\$0.091-\$0.10	\$0.091-\$0.10	\$0.101-\$0.11
Chinawood oil, bbl., lb.	.13-.13	.141-.141	.19-.19
Coconut oil, Ceylon, tanks, N. Y. lb.	.031-.031	.031-.031	.041-.041
Corn oil crude, tanks (f.o.b. mill), lb.	.071-.071	.08-.08	.071-.071
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.061-.061	.071-.071	.061-.061
Linseed oil, raw car lots, bbl., lb.	.081-.081	.086-.086	.108-.108
Palm, casks, lb.	.031-.031	.04-.04	.05-.05
Peanut oil, crude, tanks (mill), lb.	.071-.071	.081-.081	.071-.071
Rapeseed oil, refined, bbl., gal.	.75-.75	.75-.75	.75-.75
Soya bean, tank, lb.	.051-.051	.061-.061	.071-.071
Sulphur (olive foots), bbl., lb.	.071-.071	.071-.071	.101-.101
Cod, Newfoundland, bbl., gal.	.38-.38	.38-.38	.52-.52
Menhaden, light pressed, bbl., lb.	.067-.067	.069-.069	.074-.074
Crude, tanks (f.o.b. factory), gal.	.30-.30	.30-.30	.371-.371
Grease, yellow, loose, lb.	.041-.041	.051-.051	.07-.07
Oleo stearine, lb.	.071-.071	.08-.08	.09-.09
Oleo oil, No. 1.	.091-.091	.091-.091	.111-.111
Red oil, distilled, d.p. bbl., lb.	.081-.081	.081-.081	.101-.101
Tallow extra, loose, lb.	.051-.051	.051-.051	.071-.071

The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to Sept. 13

Chem. & Met.'s Weighted Price Indexes



COAL-TAR PRODUCTS

	Current Price	Last Month	Last Year
Alpha-naphthol, crude bbl., lb.	\$0.52-\$0.55	\$0.52-\$0.55	\$0.52-\$0.55
Alpha-naphthylamine, bbl., lb.	.32-.34	.32-.34	.32-.34
Aniline oil, drums, extra, lb.	.15-.16	.15-.16	.15-.16
Aniline salts, bbl., lb.	.22-.24	.22-.24	.22-.24
Benzaldehyde, U.S.P., dr., lb.	.85-.95	.85-.95	.85-.95
Benzidine base, bbl., lb.	.70-.75	.70-.75	.70-.75
Benzoic acid, U.S.P., kgs., lb.	.54-.56	.54-.56	.52-.54
Benzyl chloride, tech., dr., lb.	.25-.27	.25-.27	.25-.27
Benzol, 90% tanks, works, gal.	.16-.18	.16-.18	.16-.18
Beta-naphthol, tech., drums, lb.	.23-.24	.23-.24	.23-.24
Cresol, U.S.P., dr., lb.	.10-.11	.10-.11	.12-.13
Cresylic acid, dr., wks., gal.	.78-.80	.78-.80	.92-1.00
Diethylaniline, dr., lb.	.40-.45	.40-.45	.50-.55
Dinitrophenol, bbl., lb.	.23-.25	.23-.25	.23-.25
Dinitrotoluene, bbl., lb.	.15-.16	.15-.16	.15-.16
Dip oil, 15%, dr., gal.	.23-.25	.23-.25	.23-.25
Diphenylamine, bbl., lb.	.32-.36	.32-.36	.32-.36
H-acid, bbl., lb.	.50-.55	.50-.55	.50-.55
Naphthalene, flake, bbl., lb.	.05-.06	.06-.07	.07-.07
Nitrobenzene, dr., lb.	.08-.09	.08-.09	.08-.09
Para-nitraniline, bbl., lb.	.50-.52	.50-.52	.45-.47
Phenol, U.S.P., drums, lb.	.14-.15	.14-.15	.14-.15
Picric acid, bbl., lb.	.35-.40	.35-.40	.35-.40
Pyridine, dr., lb.	1.55-1.60	1.55-1.60	1.55-1.60
Resorcinol, tech., kgs., lb.	.75-.80	.75-.80	.75-.80
Salicylic acid, tech., bbl., lb.	.33-.40	.33-.40	.34-.40
Solvent naphtha, w.w., tanks, gal.	.26-.27	.26-.27	.26-.27
Tolidine, bbl., lb.	.88-.90	.88-.90	.88-.90
Toluene, tanks, works, gal.	.27-.28	.27-.28	.27-.28
Xylene, com, tanks, gal.	.26-.27	.26-.27	.26-.27

MISCELLANEOUS

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton.	\$22.00-\$25.00	\$22.00-\$25.00	\$22.00-\$25.00
Casein, tech., bbl., lb.	.10-.11	.09-.11	.13-.14
China clay, dom., f.o.b. mine, ton.	8.00-20.00	8.00-20.00	8.00-20.00
Dry colors			
Carbon gas, black (wks.), lb.	.02-.30	.02-.30	.04-.30
Prussian blue, bbl., lb.	.36-.37	.36-.37	.37-.38
Ultramarine blue, bbl., lb.	.10-.26	.10-.26	.10-.26
Chrome green, bbl., lb.	.21-.30	.21-.30	.26-.27
Carmine red, tina, lb.	4.00-4.40	4.00-4.40	4.00-4.40
Para toner, lb.	.75-.80	.75-.80	.75-.80
Vermilion, English, bbl., lb.	1.45-1.50	1.55-1.60	1.75-1.80
Chrome yellow, C. P., bbl., lb.	.14-.15	.14-.15	.13-.14
Feldspar, No. 1 (f.o.b. N.C.), ton.	6.50-7.50	6.50-7.50	6.50-7.50
Graphite, Ceylon, lump, bbl., lb.	.06-.06	.06-.06	.06-.06
Gum copal Congo, bags, lb.	.06-.30	.06-.30	.08-.30
Manila, bags, lb.	.07-.14	.07-.14	.09-.14
Damar, Batavia, cases, lb.	.16-.24	.16-.24	.15-.16
Kauri cases, lb.	.17-.60	.17-.60	.19-.25
Kieselguhr (f.o.b. N. Y.), ton.	50.00-55.00	50.00-55.00	50.00-55.00
Magnesite, calc, ton.	50.00	50.00	50.00
Pumice stone, lump, bbl., lb.	.05-.07	.05-.08	.05-.07
Imported, caustic, lb.	.03-.04	.03-.04	.03-.04
Rosin, H., bbl.	5.35	5.95	9.15
Turpentine, gal.	.27	.28	.35
Shellac, orange, fine, bags, lb.	.20	.20	.22
Bleached, bonedry, bags, lb.	.19	.19	.17
T. N. Bags, lb.	.11	.11	.12
Sonpetone (f.o.b. Vt.), bags, ton.	10.00-12.00	10.00-12.00	10.00-12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00-8.50	8.00-8.50	8.00-8.50
300 mesh (f.o.b. Ga.), ton.	7.50-10.00	7.50-10.00	7.50-11.00
225 mesh (f.o.b. N. Y.), ton.	13.75	13.75	13.75

INDUSTRIAL NOTES

DRIVER-HARRIS Co., Harrison, N. J., is now represented on the Pacific coast by the Electrical Specialty Co. which carries stocks of D-H alloys at San Francisco, Los Angeles, and Seattle.

INTERNATIONAL PULVERIZING CORP., Moorestown, N. J., has moved its offices to New Albany Road.

THE ONTARIO PAPER CO., LTD., Ontario, Canada, has formed a subsidiary, the Quebec North Shore Paper Co., Montreal, with paper mill at Bale Comeau.

GENERAL ALLOYS Co., Boston, has appointed Charles F. Peace as representa-

tive in Maryland with headquarters at 229 South Howard St., Baltimore, and T. Spencer Williamson as Virginia representative with headquarters at Mutual Bldg., Richmond.

EIMCO CORP., Salt Lake City, has opened a branch office at 333 North Michigan Ave., Chicago with F. E. Kurz and Paul Richter in charge.

COLGATE-PALMOLIVE-PEET Co., Jersey City, through its English branch, has purchased the business and physical assets of G. W. Goodwin & Sons, Manchester.

LINK-BELT Co., Chicago, has named

William W. Bond to succeed G. Howard Burkholder, deceased, as western sales manager of the positive drive division with headquarters at the Dodge plant, Indianapolis.

THE AUSTIN Co., Cleveland, will establish its own construction organization in England under the managing directorship of Allan S. Austin.

WORTHINGTON PUMP AND MACHINERY CORP., Harrison, N. J., has placed J. C. Barnaby in charge of special engineering work covering engine research and design. Mr. Barnaby will be succeeded in the Buffalo office by W. E. Wechter.

New CONSTRUCTION

PROPOSED WORK

Acid Plant—National Sodium Products, Ltd., Bishopric, Sask., Can., is having plans prepared for the construction of an acid plant for the production of caustic soda. Estimated cost \$50,000.

Asphalt Plant—City of Cleveland, H. H. Burton, Mayor, City Hall, Cleveland, O., plans the construction of a municipal asphalt plant. Project approved by W.P.A. R. Hoffman, City Hall, City Engr. Estimated cost \$175,000.

Ceramic Factory—Roseville Pottery Co., Roseville, O., is having plans prepared for the construction of a 1-story factory to replace warehouse unit destroyed by fire. Estimated cost \$40,000.

Chemical Plant—M. J. O'Brien, Ltd., 140 Wellington St., Ottawa, Ont., Can., has purchased property near Boxart St., Rochester, N. Y., and plans constructing a plant to grind nepheline cyanide. Estimated cost exceeds \$40,000.

Cotton Seed Oil Mill—Farmers Union, 18 North Klein St., Oklahoma City, Okla., has had preliminary plans prepared for the construction of a cotton seed oil mill at Oklahoma City. Estimated cost \$100,000.

Factory—Raybestos-Manhattan Corp., 1427 Railroad Ave., Bridgeport, Conn., plans the construction of a factory on East Main St., Stratford, Conn. Estimated cost \$100,000.

Industrial Plant—U. S. Gypsum Co., 300 West Adams St., Chicago, Ill., has purchased the property of the former Cummer Lumber Co. in the Panama Park section of Jacksonville, Fla., and plans to construct a manufacturing plant, warehouses, docks and wharves as soon as permits for wharves and dredging are approved by the U. S. War Department. Practically all gypsum building products will be manufactured from raw materials. J. P. Sanger, Chicago, Mgr. Estimated cost \$1,000,000.

Gasoline Refinery—Natural Gas Corporation, Aransas Pass, Tex., is having plans prepared for the construction of a gasoline refinery.

Oil Refinery—Dakota Refining Co., W. Nadeau, pres., Cutbank, Mont., is having plans prepared for the construction of an oil refinery at Minot, N. D. Estimated cost \$400,000.

Oil Refinery—Harrison, Ltd., 66 Marlin Lane, E. C., London, England, is having plans prepared for the construction of an oil refinery at Vancouver, B. C., Can. Estimated cost \$300,000.

Storage Building—Magnolia Petroleum Co., Magnolia Bldg., Dallas, Tex., plans the construction of a new storage and distribution plant on a 21-acre site on the Mississippi River below Chalmette, New Orleans, La. L. Lenz, Lake Charles, engineer for Company.

Sulphur Refining Plant—Aldermac Copper Co., Rouyn, Que., Can., is having plans prepared for the construction of a sulphur refining plant. Estimated cost \$400,000.

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative 1938	
	Proposed Work	Contracts	Proposed Work	Contracts
New England.....	\$100,000	.....	\$340,000	\$929,000
Middle Atlantic.....	2,540,000	\$2,865,000	8,724,000	6,528,000
South.....	1,000,000	1,225,000	21,570,000	11,052,000
Middle West.....	255,000	240,000	13,332,000	4,282,000
West of Mississippi.....	580,000	250,000	17,930,000	4,975,000
Far West.....	.....	40,000	1,180,000	3,004,000
Canada.....	750,000	900,000	19,944,000	4,760,000
Total.....	\$5,225,000	\$5,520,000	\$83,020,000	\$35,530,000

Warehouse—National Paper Co., 832 West Hubbard St., Chicago, Ill., is receiving bids for the construction of a 3 story, 40x100 ft. warehouse at Hubbard and Green Sts., Chicago. W. T. Braun, 228 North La Salle St., Chicago, Archt. Estimated cost \$40,000.

Pipe Line—Owners c/o Ford, Bacon & Davis, Inc., 39 Broadway, New York, N. Y., plan to construct 60 mi. pipe line from salt mines in Dale, Wyoming County, N. Y., to Niagara Falls, N. Y., to pump brine for use of chemical plants in Niagara Falls and vicinity. Project will include artificial lake near Linden, dam and pumping machinery. Estimated cost \$2,500,000.

CONTRACTS AWARDED

Bicarbonate of Soda Plant—Church & Dwight, Inc., Willis Ave., Syracuse, N. Y., and Solvay Process Co., Solvay, N. Y., have awarded the contract for the construction of a plant for the manufacture of bicarbonate of soda on Willis Ave., Syracuse, to Austin Co., Euclid Ave., Cleveland, O. Estimated cost \$2,500,000.

Chemical Factory—Carboloy Co., Inc., 2985 East Jefferson Ave., Detroit, Mich., has awarded the contract for 1- and 2-story, 122,000 sq. ft. chemical factory, to O. W. Burke Co., 1010 Fisher Bldg., Detroit, Mich. Estimated cost \$200,000.

Cinder Block Plant—Wilson Welder & Metals Co., 60 East 42nd St., New York, N. Y., subsidiary of Air Reduction Sales Co., has awarded the contract for the construction of a 1-story, 100x100 ft. cinder block plant at Sparrows Point, Md., to Consolidated Engineering Co., 20 East Franklin St., Baltimore, Md. Estimated cost \$100,000.

Distillery—Calvert Distilling Co., Relay, Md., has awarded the contract for the construction of a 5-story, 60x60 ft. cooker and still building to Hays & Nicoulin, 3928 Massie Ave., Louisville, Ky. Estimated cost \$60,000.

Factory—Gladding, McBean & Co., 79 S. E. Taylor St., Portland, Ore., has awarded the contract for the construction of a 1-story factory building for the manufacture of clay products and building materials at S. E. Main St. and Second Ave., Portland, to Drake, Wyman & Voss, Inc., U. S. Bank Bldg., Portland, Ore. Estimated cost \$40,000.

Factory—Minnesota Mining & Manufacturing Co., Forest and Fauquier Sts., St. Paul, Minn., has awarded general contract for constructing 4-story, basement factory, to W. M. Murphy & Son, 428 New York Bldg., St. Paul, Minn. Estimated cost \$250,000.

Factory—Mundet Cork Corporation, 65 West 11th St., Brooklyn, N. Y., has awarded the contract for the construction of a 1-story, 100x300 ft. factory on Bloy St., Hillside, N. J., to White Construction Co., 95 Madison Ave., New York, N. Y. Estimated cost \$100,000.

Glass Factory—Maryland Glass Corp., Baltimore, Md., has awarded the contract for 1-story factory, to Cummins Construction Corp., 803 Cathedral St., Baltimore, Md. Estimated cost \$25,000.

Paper Plant—International Foils, Ltd., c/o R. T. B. Schreiber, 3810 St. Antoine St., Montreal, Que., Can., has awarded the contract for constructing an industrial plant for production of aluminum foil and tissue paper for cigarette wrapping in Cap de la Madeleine, Que., to Fraser-Brace Engineering Co., Ltd., 107 Craig St., W. Montreal, Que. Estimated cost \$900,000.

Paper Machine Building—Scott Paper Co., M. Watson in charge, Chester, Pa., has awarded the contract for the construction of a paper machine building to Wark & Co., 1608 Walnut St., Philadelphia, Pa. Estimated cost \$80,000.

Plant—Chromium Corporation of America, 4645 West Chicago Ave., Chicago, Ill., has awarded the contract for constructing a 50x125 ft. top addition to its plant on Chicago Ave., to R. G. Regan Co., 228 North La Salle St. Estimated cost \$40,000.

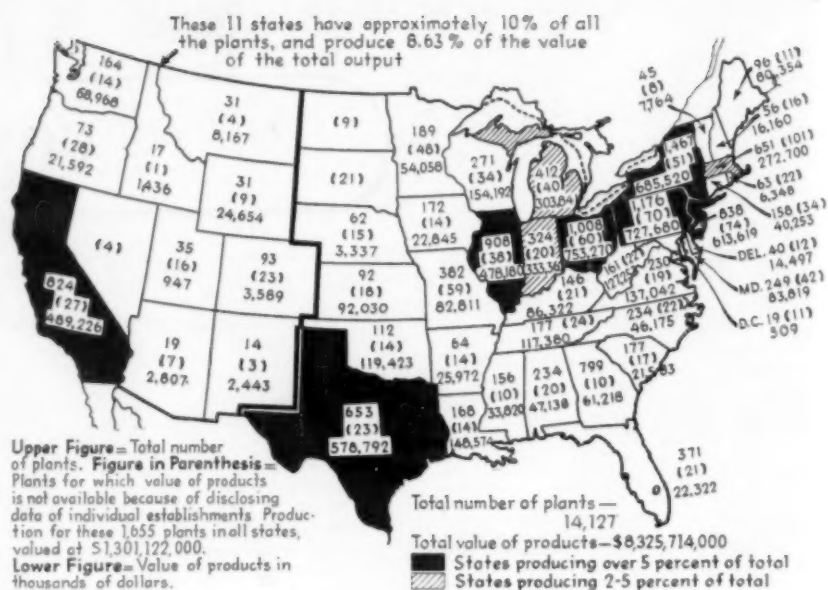
Rayon Mill—E. I. du Pont de Nemours & Co., Du Pont Bldg., Wilmington, Del., will construct an addition to its rayon mill at Amphill near Richmond, Va. Work will be done by company forces. Estimated cost \$1,000,000.

Warehouse—Frankfort Distilleries, Columbia Bldg., Louisville, Ky., have awarded the contract for the construction of a 10-story, 143x170 ft. rack warehouse at Dundalk, Md., to Cummins Construction Co., Cathedral St., Baltimore, Md. Estimated cost \$225,000.

PROCESS INDUSTRIES IN WESTERN STATES

A study of the Census data for 1935 reveals that the process industries are expanding in the 11 western states which make up the Pacific Coast area. California holds the ranking place both from the standpoint of number of plants and of value of products. Petroleum refinery products account for nearly one-half of the total valuation with chemicals and related products reaching a figure of approximately \$102,000,000.

Washington rates the second position with a varied line of process industry plants topped by pulp and paper production which had a value in excess of \$53,000,000 in 1935. Colorado was carried into third place by virtue of its leadership in beet sugar.



Chemicals and Allied Products of Western States

(Census of Manufactures — 1935)

	No. of Establishments	Salaried Employees	Wage Earners Average For year	Salaries	Wages	Cost of Materials, Containers, Fuel and Purchased Energy	Value of Products	Value Added Manufacture
California								
Blackings, Stains, and Dressings	7	23	23	\$50,079	\$20,305	\$164,182	\$343,048	\$178,866
Candles	4	13	22	14,056	12,186	34,162	76,271	42,109
Chemicals, not elsewhere classified	52	791	3,150	1,883,094	4,083,770	10,733,562	27,664,660	16,931,098
Cleaning and Polishing Preparations	24	52	60	118,322	60,340	383,256	894,130	510,874
Compressed and Liquefied Gases	26	138	220	302,029	286,346	910,177	2,980,974	2,070,797
Drugs and Medicines	52	223	423	424,700	411,984	1,236,739	3,856,609	2,619,870
Explosives	4	69	399	173,395	530,071	2,045,072	4,922,878	2,877,806
Fertilizers	29	98	269	194,951	262,513	2,437,858	4,282,850	1,844,992
Grease and Tallow	19	41	332	125,672	440,201	1,877,352	3,073,839	1,196,487
Ink, Printing	9	46	166	153,662	214,503	1,091,639	1,705,833	614,194
Insecticides, Fungicides, etc.	52	118	284	250,956	299,076	2,300,825	3,932,261	1,631,436
Mucilage, Paste, and Adhesives	6	11	11	37,147	12,251	87,341	170,802	83,461
Oil, Cake and Meal, Cottonseed	6	63	184	122,479	122,397	3,904,194	4,751,222	847,028
Oils, not elsewhere classified	30	156	658	341,260	684,374	8,563,138	15,495,921	6,932,783
Paints, Pigments, and Varnishes	101	498	1,356	1,013,912	1,677,864	14,685,824	25,693,741	11,007,917
Perfumes, Cosmetics, Toilet Preparations	32	131	376	339,835	427,665	1,636,386	4,193,937	2,557,551
Salt	9	60	417	220,468	463,695	883,166	2,585,199	1,702,033
Colorado								
Chemicals, not elsewhere classified	3	5	55	12,200	61,086	140,577	284,256	143,679
Cleaning and Polishing Preparations	5	7	6	12,454	5,576	19,109	129,680	110,571
Compressed and Liquefied Gases	6	15	58	41,912	58,781	127,113	413,163	286,050
Drugs and Medicines	9	26	41	60,112	39,705	119,921	383,416	263,495
Grease and Tallow	5	0	47	26,043	51,832	143,858	289,724	145,866
Insecticides, Fungicides, etc.	5	8	8	11,713	6,930	29,628	79,983	50,355
Paints, Pigments and Varnishes	4	19	40	40,490	52,194	287,333	490,886	203,553
Perfumes, Cosmetics, Toilet Preparations	3	5	9	6,054	7,249	46,547	79,699	33,152
Arizona								
Oil, cake and meal, cottonseed	3	13	95	51,740	60,320	1,802,701	2,573,876	771,175
Oregon								
Insecticides, Fungicides, etc.	5	6	16	6,546	8,995	45,956	74,753	28,797
Paints, Pigments, and Varnishes	10	23	92	41,861	89,177	729,082	1,256,626	527,544
Utah								
Compressed and Liquefied Gases	5	17	31	28,636	38,059	76,629	246,579	166,950
Washington								
Chemicals, not elsewhere classified	7	44	156	95,086	154,744	847,872	1,960,315	1,112,443
Compressed and Liquefied Gases	10	42	64	85,318	76,408	207,330	683,988	476,658
Drugs and medicine	6	12	14	23,312	19,675	36,608	135,648	99,040
Fertilizers	5	14	29	25,511	22,728	214,199	379,820	165,621
Glue and Gelatine	4	46	57	96,934	73,843	401,424	777,373	375,949
Insecticides, Fungicides, etc.	12	12	22	25,611	20,652	143,751	238,419	94,668
Paints, Pigments and Varnishes	12	42	83	101,167	88,111	535,404	1,004,231	468,827
Perfumes, Cosmetics, Toilet Preparations	6	15	16	44,623	12,554	58,825	170,302	111,477